OCTOBER, 1957
Volume 11

FT food technology

THE JOURNAL OF THE INSTITUTE OF FOOD TECHNOLOGISTS

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THE TECHNICAL ARTICLES IN BRIEF

Physical measurement *Potato granules*

A physical test for consistency of potato granules. W. R. Mullins, A. L. Potter, Elizabeth R. Wood, W. O. Harrington, and Robert L. Olson.

When a ball of rehydrated potato granules was allowed to fall upon a surface, the diameter of the resultant cake was found to be related to consistency or rubberiness as determined by a panel of trained judges. Reconstituted experimental and commercial samples of granules showed a high degree of correlation between cake diameter and subjective values for rubberiness over a substanial range in consisteney, which was essentially independent of the soluble starch content. Diameter tests on samples of potato granules mechanically damaged by abrasion to lower the texture quality by release of free starch also were correlated with texture determined by the panel and with the Blue Value Index for soluble starch. (See page 509)

Stabilization, enzymatic *Beer*

Use of glucose oxidase to stabilize beer. Donald W. Ohlmeyer.

Deterioration and spoilage of beer during storage are caused by oxidation reactions. Results of the deterioration are obvious to the consumer as change in taste, color, and brilliance of beer. That these changes are due to oxidation is substantiated by measurement of the oxygen to air ratio, the Indicator-Time Test values, and the proportion of total protein found in the high molecular weight fraction.

Glucose oxidase inhibits these oxidation reactions in pasteurized beer and decreases iron pickup from the can. Its effectiveness in retarding spoilage of unpasteurized beer, by inhibiting the growth of yeast, is demonstrated. It is shown that the minute amounts of glucose normally present in beer are sufficient to enable the glucose oxidase system to function and to catalyze the reaction of free oxygen with glucose to form gluconic acid.

Tests to determine the progress of oxidation with time show that treatment with glucose oxidase enables pasteurized beer to maintain brewery freshness for many months, and even makes it possible to keep unpasteurized beer without refrigeration for several weeks. (See page 503)

Curing *Sawdust vs. friction smokes*

Fractionation of wood smoke and the comparison of chemical composition of sawdust and friction smokes. Saeed A. Husaini and G. E. Cooper.

The smoke generated by burning sawdust as by friction of a rotating metal disc against small wood blocks was condensed at −80° C. and analyzed. On steam distillation of either type of smoke condensate, the distillate was found to contain most of the smoke odor and flavor, whereas the non-steam volatile portion retained most of the dark brown color, but negligible smoke odor and flavor.

Most of the acids in sawdust and friction smokes were found to be steam volatile. Of all the steam volatile acids acetic acid occurred in the greatest amount. Formic acid was next in order of the amount present.

The friction smoke was richer in the desirable compounds than sawdust smoke. It contained less moisture, four times more steam volatile acids and eight times more steam volatile aldehydes and ketones than sawdust smoke. Steam volatile phenolic compounds were also greater in the friction smoke. The non-steam volatile portion of either type smoke was found to be very undesirable for smoking of bacon. (See page 499)

Stabilization, enzymatic *Eggyolk solids*

Effect of glucose removal on storage stability of eggyolk solids. Pauline Paul, Helen Symonds, Aileen Varozza and George F. Stewart.

Eggyolk solids which had been enzyme-treated to remove glucose were compared with untreated solids in respect to storage stability. Samples of each lot were stored at 95° F. for 7, 14, 25, 40 and 90 days, and at 68° F. for 3, 6, 9 and 12 months. Additional samples were stored under refrigeration for use as controls. Doughnuts were selected as the product in which to test the quality of the yolk solids. Performance was evaluated on the basis of fat content, specific volume, and eating quality of the doughnuts.

The enzyme treatment materially improved the storage stability of the eggyolk solids at 95° F., the untreated sample giving doughnuts of lowered fat content and decreased palatability as the storage time increased. Similar results were obtained in the 68° F. storage series; however, the differences were much smaller than in those stored at 95° F. (See page 494)

Pasteurization *Liquid Eggyolk*

Effects of several pasteurization schedules on performance of yolk solids in doughnuts. Pauline Paul, Aileen Varozza, George F. Stewart, and Dwight H. Bergquist.

Four different time-temperature pasteurization treatments were given liquid egg yolks before drying: 140° F., 4 minutes; 142° F., 2 minutes; 144° F., 1 minute; 146° F., ½ minute. All these treatments caused marked and similar reduction in bacterial counts. There was little or no difference in performance of the yolk solids in doughnuts due to treatment. Changes in fat content were not great enough to be statistically significant, or to affect appreciably the eating quality of the doughnuts. Significant difference in fat content and volume was found between the two doughnut mixes used. (See page 508)

Wine preservation *Vitamin K_5*

Vitamin K_5 as a preservative for wine. J. N. Casper and H. Y. Yang.

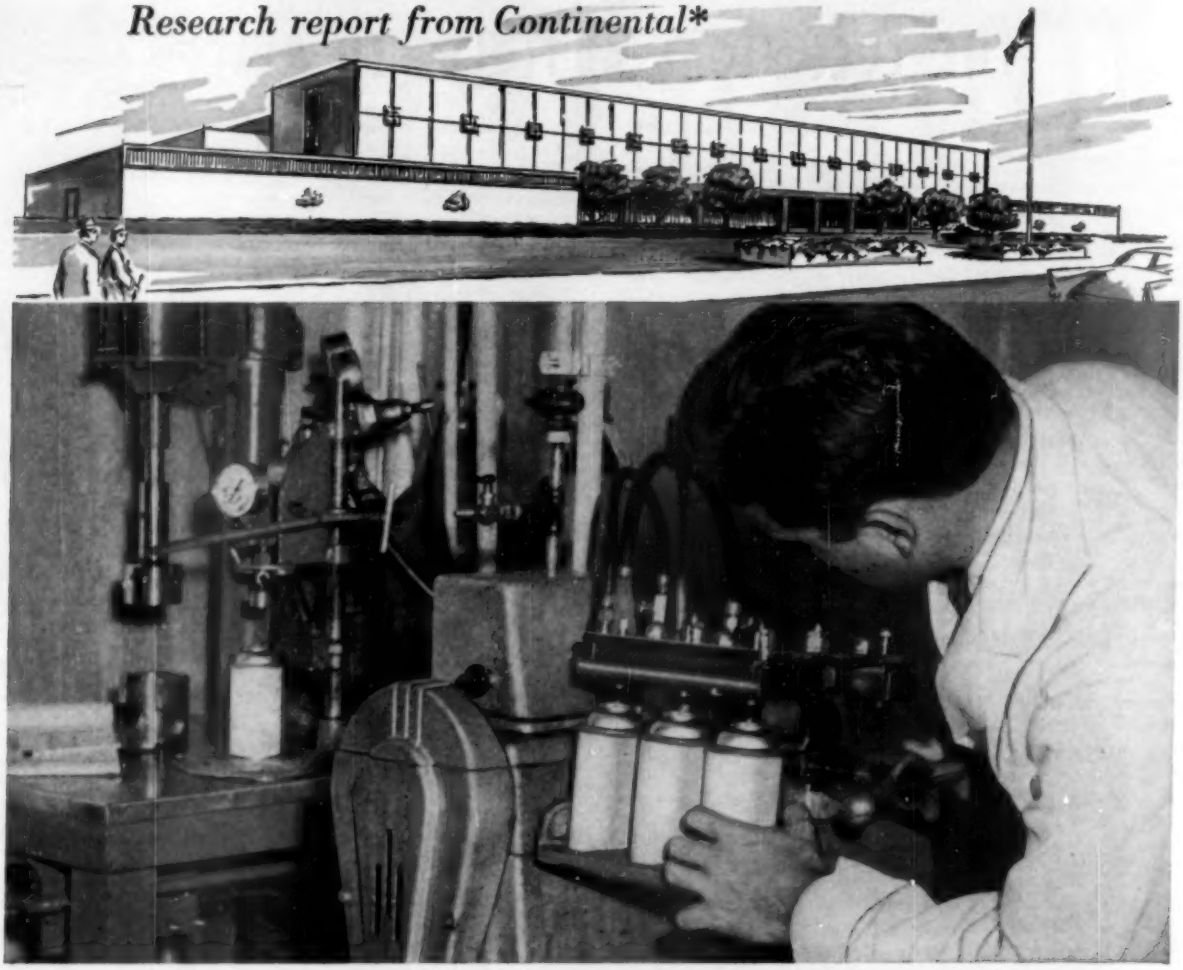
Sulfur dioxide has been used as a chemical preservative for wine for many years. At the present time, it is still the only legal preservative for wine. Use of sulfur dioxide,

Continued on page 21

OCTOBER COVER

As in other branches of food technology, the technology of baking is supported by intensive laboratory work. Shown on the October cover is a research laboratory with personnel engaged in the assay of amino acids and vitamins. Courtesy American Institute of Baking.

*Research report from Continental**



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FT *food technology*

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Towards A More Uniform Professional Training For Food Technologists[a]

A report of the Accreditation Sub-Committee of the 1956-1957 IFT Committee on Education[b]

L. J. Kenyon, F. K. Lawler, and C. O. Ball

IT IS PERHAPS SUPERFLUOUS for me to say that there are as many shades of opinion in areas of training, curricula and accreditation as there are food technologists. Many of them are generated by personal experience, and, whereas they are undoubtedly valid, they are generally not sufficiently objective to greatly influence deliberations which of necessity must be confined to basic matters of considerable breadth. We, the Sub-Committee, have nevertheless tried to take them into account in our deliberations. We were fortunate in having the background of investigation pursued by the previous committee whose work we have continued. The Sub-Committee has worked with diligence, imagination, and a sense of dedication to ideals. This has been a gratifying experience to me. We believe we have produced suggestions and recommendations worthy of further consideration and amplification.

L. J. Kenyon

It is immediately apparent that none of the problems presented to us can be considered independently of any of the others. Their implications impinge upon each other at every point. It is, for example, quite obvious that it is difficult to approach the subject of accreditation without a blueprint of curricula which would be imposed for this purpose. When you try to evolve a program of study for accreditation, you run into great divergencies among the nation's universities in respect to available physical and other facilities. Of at least equal importance, there is a complete lack of uniformity of purpose among Departments of Food Technology. Therefore, it became necessary for us to take a philosophical approach, recognizing that the accomplishment of our final objectives was a number of years in the future.

We started off with the assumption that a curriculum could be established that would meet with universal approval and be adopted as a standard for accreditation. We agreed that a B.S. in Food Technology, awarded by an accredited school, would carry with it many desirable advantages. It is hardly necessary to go into these since they are so obvious and have been well covered in previous deliberations. Our concerted opinion was that, unless a preponderance of valid objections could be produced, accreditation would unquestionably be advantageous.

The National Commission on Accrediting in Washington, D. C. was approached on the subject of accrediting schools offering Food Technology. Complications arose which brought into this subject problems that are outside the scope of the assignment of this Sub-Committee and which will be handled by others. However, this circumstance did not alter our activities within the limits of the assignment.

PREREQUISITE: A SCIENTIFIC "CORE OF KNOWLEDGE"

Early in our deliberations it became obvious that, if we were to achieve any worthwhile accomplishment, it would be imperative to concentrate our thinking on essentials. We decided we would eliminate from consideration all fields of study except the scientific "core of knowledge" that would be a requisite for anyone about to enter the technological food field. We are in agreement that, aside from the scientific subjects, an ideal course should present prescribed and elective courses to produce a well-rounded graduate. However, we felt that, if we were to attempt to prescribe any such course matter, we would achieve nothing but confusion to the detriment of our primary objective. Our immediate problem was therefore the definition of the minimum scope of technical knowledge that would produce a true scientist.

If we agree that a graduate of a course in Food Technology must be familiar with basic concepts covering a broad range of information, it is then our responsibility to prescribe the course material that

[a] Presented before the Seventeenth Meeting of IFT, Pittsburgh, Pennsylvania, May 14, 1957.

[b] The Sub-Committee on Accreditation, L. J. Kenyon, chairman, was appointed and charged with 4 primary tasks. One of them was to endeavor to establish desirable and undesirable facets of accreditation for the Bachelor of Science degree in Food Technology, throughout the universities of this country. The other 3 duties imposed upon the Sub-Committee were: (1) to delineate types of training that should be offered to potential Food Technologists; (2) frame a basic curriculum of fundamental sciences that would be common to all types of training; (3) suggest programs of study to supplement the basic science curriculum to accommodate the needs of special sections of the food industry.

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should produce such a result. There are many inherent difficulties in attempting to designate these courses by name since each college devises its own curricula by standards which may be individually arbitrary. Nevertheless, there are enough basic similarities so that minimal standards can in general be assumed. It is also common practice to require prerequisites for advanced courses, so that a proper course designation will safely presuppose the achievement of prior preparation for it.

Our Recommendations

It is on this basis that we have built our recommendations. We have used the names of the branches of study, qualifying their caliber and prerequisites by characterizing them in terms of the student's yearly level of classification. As an example, a course designated as "Chemistry—Second Year Level" would mean any course in chemistry requiring three or more class sessions per week, or the equivalent, and which would carry a prerequisite of one year of chemistry at the first-year level. Thus, a course in quantitative analysis would qualify as second-year level, carrying as a prerequisite the first-year level course of qualitative analysis.

With this explanation of terms we present the curriculum that we believe should form the basis of accreditation:

COURSE RECOMMENDATIONS

First-Year Level

Mathematics	Physics
English	Engineering
Chemistry	Bacteriology
Biology	

Second-Year Level

Mathematics	Food Technology
English	Engineering [1]
Chemistry	

Third-Year Level

Chemistry	Engineering [2]

Fourth-Year Level

Food Technology

It is our considered opinion that this curriculum, along with electives and those courses additionally prescribed by the individual college, will produce a graduate who will have an exceptionally broad base of understanding of science as applied to the food industry. It will then be the function of industry or the graduate school to provide the incentives and the means for specialization. With such a background, the young food technologist can readily enter any of the fields of research, technical service, manufacturing, control, development, technical sales, technical administration or teaching.

Supplementary Training

With the evolvement of this program of study, we have performed all the duties requested of us, with one exception. We were asked to suggest supplementary training pointed toward the needs of special sections of the food industry. This we have intentionally refrained from doing. It is our confirmed and unanimous opinion that there is no room in the undergraduate course for any degree of such specialization that could be meaningful in any circumstances. It has seemed to us that the student would be better advised to participate in courses such as Advanced English, Philosophy, Ethics, History, Economics and the like, or in those courses where his natural inclinations would take him.

If we were to attempt to qualify courses leading to specialization, we would find ourselves wandering far afield into the areas of the trade school and technological institute. The possibilities for providing the student with information about special sections of the food industry are myriad, and there is no certain place for beginning nor for ending. With the asset of the wide scope of general scientific knowledge our recommendations can provide, the graduate should find himself sufficiently well equipped to make a positive contribution of intelligent effort in any field he chooses.

[1] Two courses if in different branches of engineering.

[2] Not to be included in case two courses on the second-year level are taken.

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

October 9-11	Fourth Annual Symposium on High Vacuum Technology, Hotel Somerset, Boston, Massachusetts
October 14-16	Association of Official Agricultural Chemists, Shoreham Hotel, Washington, D.C.
November 18-December 9	Ninth Pacific Congress of the Pacific Science Association, Chulalonghorn University, Bangkok, Thailand
December 26-31	American Association for the Advancement of Science, Indianapolis, Indiana
1958	
January 27-30	Plant Maintenance and Engineering Show, International Amphitheatre, Chicago, Illinois
April 7-11	The American Association of Cereal Chemists, Netherland-Hilton Hotel, Cincinnati, Ohio
May 25-29	**Eighteenth Annual Meeting of the Institute of Food Technologists, Palmer House, Chicago, Illinois**

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, 11606 South Bell Avenue, Chicago 43, Illinois notices of annual or national meetings of interest to food technologists.

The Time Has Come•

Lloyd A. Hall

The Griffith Laboratories, Inc., Chicago, Illinois

IN OUR FAST-MOVING WORLD, it seems only a few years since 1939, the year the Institute of Food Technologists was officially organized, and 1940, when the first annual meeting was held, with some anxiety and trepidation, in Chicago. Here we are, attending the 17th annual meeting of our Institute, grown larger and more important than the most enthusiastic dreams of the Founders envisioned, and in a late adolescent stage, already the father, teacher, and consultant to the food industries. The keen foresight of the Founding Members cannot be too highly praised for the vigorous thought and tremendous work they contributed to the establishment of this Institute and the amazing progress it has made because of their careful nurturing. Together with the founding and growth of our Institute has been an inevitable corollary, the birth of a new type of scientist —the Food Technologist.

Lloyd A. Hall

Since we have successfully reached this stage of growth and attained the acceptance that we now have, it seems only proper that careful and serious consideration be further given to improving our professional status. This is the basis for my discussion today. There are many facets to this problem and a full day's symposium or more would be necessary to explore it properly. And so I wish to confine myself substantially to the public or human aspect.

Outstanding among scientific societies that have given realistic thought and objective action to the professional status of their members has been the American Institute of Chemists and the American Chemical Society. We are very youthful in comparison to the age of these societies, but we have in our Institute many members of both of these fine organizations who are aware of the planning and functioning of these societies. They would agree, I feel sure, that we could pattern and probably improve our own operations in the area of professional status by the precedents of these societies.

I had the privilege, several years ago, of serving on the Committee on Public Relations of the American Institute of Chemists, and on the Committee on Public Relations and Publicity of the Institute of Food Technologists. There was a considerable difference in what these two committees were striving for and attempting to do. As many of you know, the American Institute of Chemists is presumably organized to advance their members professionally and thus to advance the profession itself. Professional status, therefore, is one of the prime objectives of the AIC and what they do is indirectly helpful to the IFT and other scientific societies. This committee was concerned with the relation of their members to industry, to the profession, to Government, to the general public and to management. It was designed to reach every one of these groups through publications of the Institute, through members, through press and public relations and through ethical advertising. The scope of such a problem has a broad spectrum and such a committee must have the guidance and encouragement of their Executive Board. The AIC has, for many years, had a strong and active Public Relations Committee which has functioned continuously and, in the opinion of many persons, has done an excellent job.

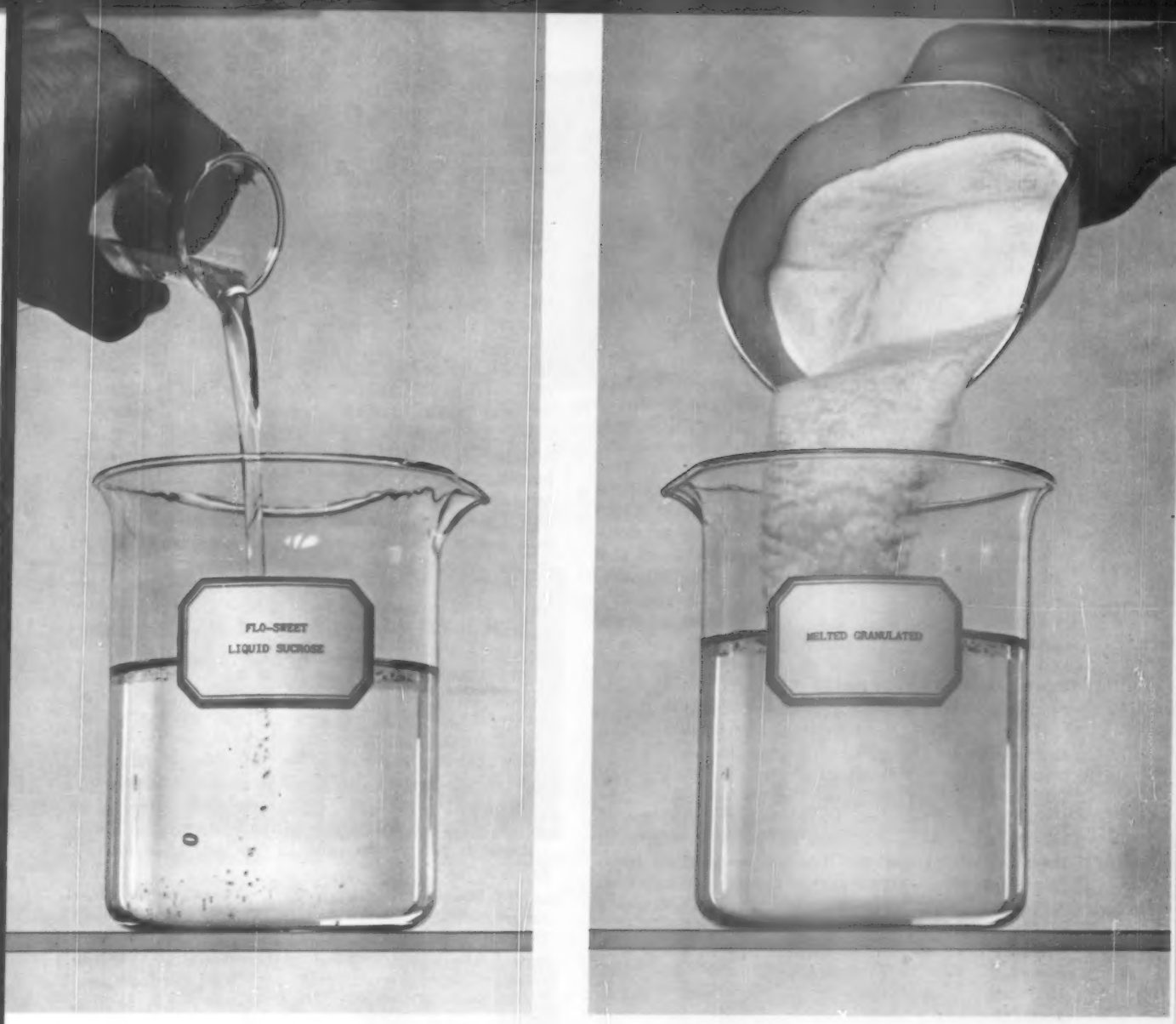
In order to do this, they have used all of the means that I have described and many more, some of which include the establishment of strong professional standards, advising on legal matters and chemists' contracts, maintaining close and helpful relations with other technical and professional societies, assisting in determining standards of professional training in educational institutions, and interesting students in obtaining a scientific education for use in industry.

In 1952 and 1953, I served on the Publicity and Public Relations Committee of the IFT. This was an enthusiastic committee whose deliberations ended in proposing a very ambitious program which included three vital points:

1) To increase interest and support of executives of the food processing industry and supplier companies;
2) To obtain better interest and progressive support from present members of IFT and its officers;
3) To develop an understanding of the consuming public (e.g., the housewife and others)—on industry problems and efforts to raise quality and nutritional levels of foods.

A start on these suggestions has been initiated by our Institute but there is far more to be done to accelerate the objectives set forth in this report (and which were presented to the Executive Committee and Council in 1953). Since that time, our thinking indicates that a continuing virile and working committee could contribute to and accentuate much that the 1952-1953 Publicity Committee did not carefully consider or was unable to accomplish.

• Presented before the Seventeenth Annual Meeting of the IFT, Pittsburgh, Pennsylvania, May 14, 1957.



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"This Intriguing Matter of Professional Status"

One of the immediate problems of today which concerns the technical man in modern industry is this intriguing matter of professional status. He is often unhappy about the lack of professional recognition accorded him and is usually pretty uncertain as to what to do about it. The concept of professional status with which we are dealing assumes some training and technical confidence in our field or in some field of specialization. It more or less takes for granted that a member of a profession, in view of the quality of his training and ability, has capacity for understanding initiative and leadership in his field. Furthermore, it involves responsibility for intelligent and judicious advice and service not only to clients or our company but also to society as a whole. The possession of these qualifications and the recognition of them is the basis for status differential that separates the professional man from the average layman.

Otherwise there are no good reasons to support the concept, popularly held, that scientists or Technologists are some sort of super persons, as magical and mysterious as they are all-powerful. Arrogant from their successes, they are assumed to be avid to invade and conquer, one after another, all the fields of human activity and thought. This picture of us is completely in the category of abstract art.

If the public could be brought to understand and appreciate that we are like other normal individuals, trained and experienced in a special scientific profession for human service, they would lose their combination of mistrust, fear, and over-estimation of us. Actually, I do not think the public would treat the scientists part of the time as amusing but beneficial eccentrics, another part of the time as sorcerers, and another part of the time as irresponsible rascals, if they had honest and sufficient information about us.

David Brewster, one of the founders of the British Association for the Advancement of Science, said 125 years ago: "The principal objects of the Society would be to make the cultivators of science acquainted with each other, to stimulate one another to new exertions, to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress."

Speaking of the present-day scientist, one important industrialist has said, "Outside his laboratory, his task is to educate us in what goes on inside it, and to give it a meaning for us. In a world in which statesmen as much as voters are ignorant of the simplest implications in science, this is a formidable responsibility."

These two statements, made more than a century apart, are amazingly similar in thought. Apparently, we have been so busy and preoccupied with our research and development, that *status* has been largely overlooked in the interim.

A TWO-FOLD FUNCTION

The Technologist has a two-fold function: That of directing the material phases of industrial problems on the one hand and, on the other, controlling the human factors involved. There is no failure on the part of our Technologists to recognize the importance of the problems of the first type and, most significant, no lack of confidence in handling them. We develop new products; we discover new syntheses and new uses; we improve processes and reduce costs. The trouble is that all too frequently we look on these entirely necessary activities as ends in themselves and we evaluate professional competence on the basis of effectiveness in this area of handling material things. We lose sight of the fact that the problems of human relationships are no less essential than the control of material factors and when we do this, we degenerate from the status of Technologists to that of technicians. If the Technologist is to handle the human problems of his professional area with confidence, he must be able to deal constructively with three different fields. In the first place, he must handle his own personal problem of psychological adjustment to his personal work. He must have faith in its importance and find satisfaction in its activities. He must develop an emotional equilibrium and poise which will carry him reasonably through difficulties and inspire the confidence of those around him.

In the second place, he must be a master in the art of dealing with people, whatever their levels with respect to his own position. Third and finally, he must have an understanding of the economic, social, political and international environment so that he can adjust himself and his work constructively to meet the deepest needs of the society of which he is a part. It seems to me that in the first two, the Technologist is fairly weak and in the last, he is almost helpless.

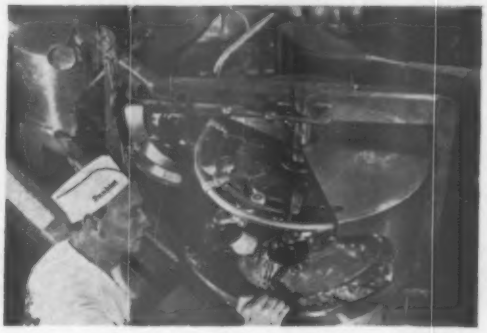
Our responsibility as Food Technologists in present-day society cannot justify an attitude of indifference to matters we think are foreign to our business connections. Thus, it is important that we ask ourselves where our duty lies and what the facts are. It cannot be emphasized too strongly that professional stature involves accepting the responsibilities that go along with our special position in society. Always important, where there is at stake the very means by which we may perform our technical or scientific duties, contribute to the defense of our homes, and supply our proper effort in the advancement of our social system, our professional behavior becomes a vital thing. It is not alone a question of our individual preferences, but to a great extent, it is a question of declaring widely the professional standards to which we adhere and require of all others who wish to be recognized as members of our profession.

Public Relations

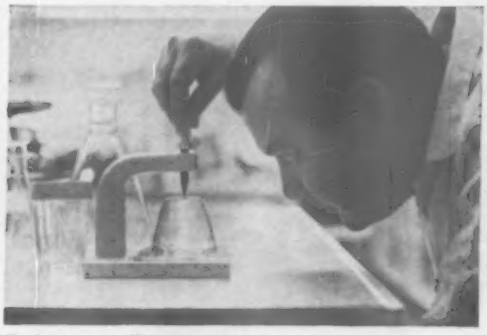
Professional responsibility carries with it recognition by the public, and public recognition and appreciation cannot be bestowed by Government edict. Legislatures may define what a profession is for legal purposes, but what we primarily are seeking is esteem and prestige and dignity. On such basic

One look at the huge, sprawling buildings at one of the Exchange Products plants and you know that big things are happening inside. For here *citrus* is king. Trucks pour in with fresh fruit from groves all over California and Arizona. Conveyer belts hum along in every direction. And Exchange products are shipped to nearly every part of the world.

Why 'Exchange' products serve you better



Utmost cleanliness is the watchword at Exchange Products plants. Everything has that "just washed-down" look. Every four hours, extraction equipment is completely cleaned. Every third day, the entire plant closes down for a thorough washing.



Exchange quality is assured by constant checking in extensive testing laboratories. In fact, rigid quality controls have been set up *throughout* the plant to make sure that every product measures up to Exchange quality. Sunkist produces more than 400 different citrus products.

The world's largest citrus research department is maintained by the Sunkist Growers to develop new growing methods, to improve manufacturing processes, and to perfect better products. Today, with a backlog of more than 60 years experience, Sunkist has accounted for 118 separate U.S. patents.

Just three of many Exchange products are *Exchange Preserver's Pectin*—guarantees a more uniform finished product; *Exchange Low Methoxyl Pectin*—jells *without* sugar, tasteless, controls "weeping" in pies; *Exchange Lemon Juice*—brings out natural flavor of *any* food. Superior acidulant, excellent anti-oxidant.

Sunkist Growers
PRODUCTS DEPARTMENT • ONTARIO, CALIFORNIA

Distributors for
Exchange Lemon Products Co., Corona, Calif. • Exchange Orange Products Co., Ontario, Calif.

concepts, publicity and public relations can be really effective.

What are Public Relations? In principle, there is nothing different between neighborhood relations for a family and public relations for a business. The practice of public relations lies in the art of knowing how to get along with people, and this, in turn, is largely a matter of letting people know who you are, what you are, what you believe, and what you stand for. Simply defined, the task of public relations is the task of telling people the facts about yourself. It is primarily a communications job, which is done by one or all of three methods: by writing, by speaking, and by pictures. Whatever method is used, the job must be done modestly, in good taste, and convincingly.

Actually, this matter of public relations for business and the public has become so important in recent years that many business concerns have appointed vice presidents in charge of publicity and public relations. They have become excellent assets to top management and the profitable progress of the company.

When we have recognized and firmly established our professional responsibility, we are then ready to seek public recognition and appreciation. Since nothing is more important to life than food, it should not be too difficult to tell our story in understandable language to the public. As I have said, the Food Technologist is a relatively new type of scientist and people are interested in what he is and what he does to make their life less hazardous, more enjoyable and healthier.

Let me reiterate—the public in general still pictures and often thinks of the scientist as a "long-hair," and catalogues him as a rather peculiar, studious introvert. Personally, I become furious when confronted with such connotations and descriptions, for we all know their absurdity. Even the atomic age of *now* has not lessened to any great extent this general opinion about us. There must be a reason for this, and, plainly stated, I believe it is that there is a mystery about what we do and how we do it. We should do something about it. I recognize that, to a surprising extent, we are, but we should always bear in mind that, as we become increasingly articulate about our professional work, we will more and more assume the standing of normal individuals in the public eye.

Undoubtedly, we are all concerned with recognition. Recognition is tied in with our responsibilities. If one of us is fortunate enough to reach top management status, he can become an important factor in helping others to gain recognition, should they deserve it. This is the same as saying that we should rise to full professional stature by accepting the responsibilities that come with our special, and important, position in society and those, as well, that accrue from performing our scientific duties. Accomplishing this is not as easy as it sounds, but it has been done by many people and there are numerous examples we are all aware of.

Discussions on professional status frequently are based on comparisons with the legal and medical professions. An approach of this kind, in my opinion, is not productive. Does the medical profession evaluate its professional status by that of the legal profession, or vice versa? They may compare notes on economic status but not on professional status. Although economic status is important, this seems, in the majority of cases, to take care of itself after responsibilities are efficiently handled and after recognition has been gained.

IMPLEMENTING A PUBLIC RELATIONS PROGRAM

One very large chemical company uses the slogan: "Better things for better living through chemistry." A public relations program needs a "pivotal" phrase. It is not so minor a point as one might think. We might suggest, "More nutritious and appetizing food for longer life, through food technology," or some phrase of this sort for IFT. Our public relations program is ready at this point, but it will take desire, effort, with every one of us collaborating as a team to put it over.

First of all, a public relations program will require Institute approval and support and some subsidy. A strong and enthusiastic committee would need to be appointed, preferably composed of persons familiar with the field of public relations, advertising, or sales—and with a background of

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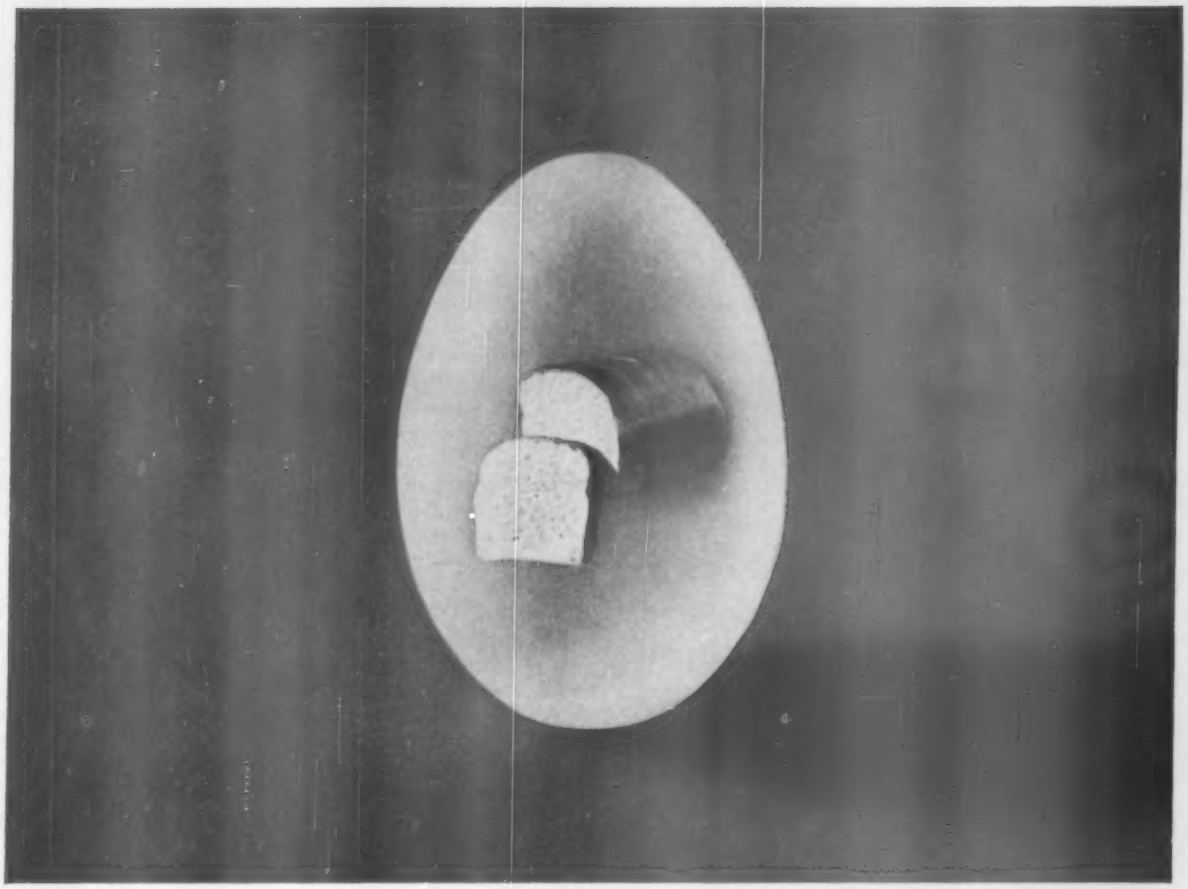

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The lysine content of wheat flour protein, for example, needs to be approximately doubled in order to make its amino acid balance comparable to that of efficient, high quality egg protein.

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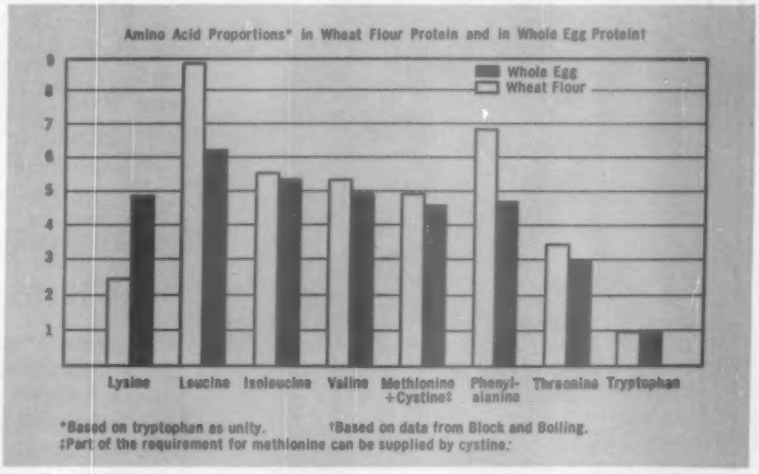
*Before adding L-lysine to food products, manufacturers should check Federal and State standards of identity.



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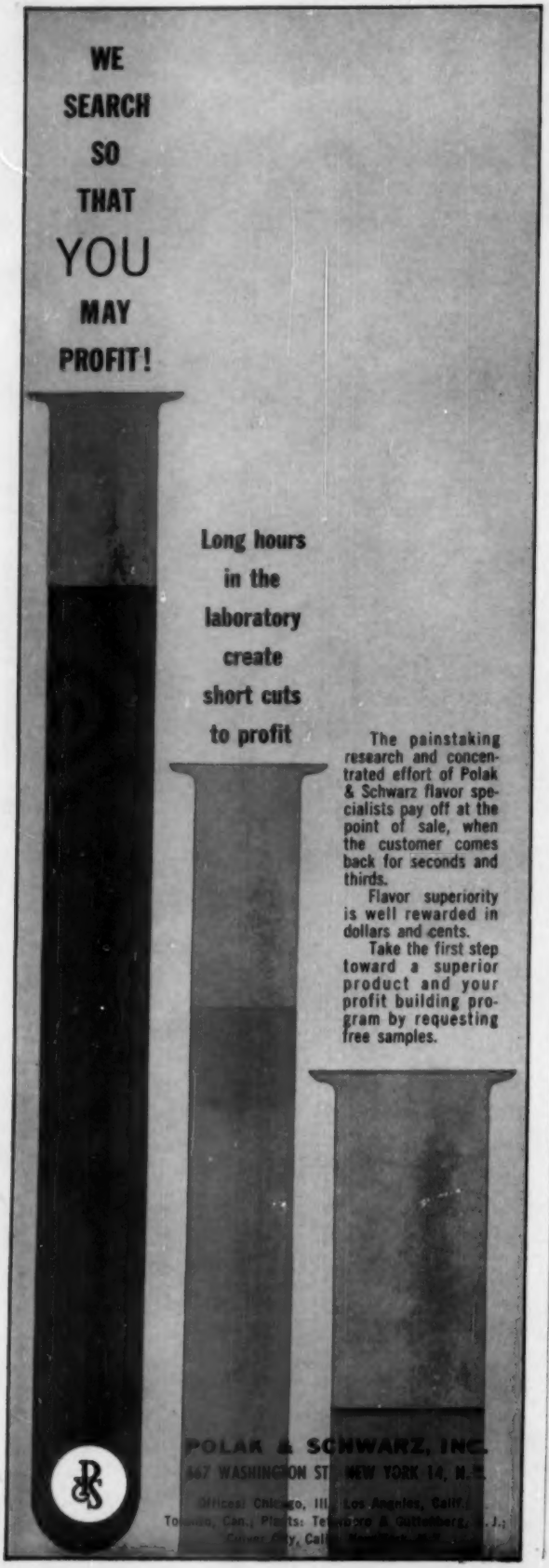
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professional experience as food technologists. An experienced person in public relations or in a closely allied field as a paid staff member would be a most valuable asset. This committee would set up an objective program or operating plan for approval of the membership and, should this be forthcoming, action and the continuous work of its members, from this time on, would be the key to the success of such a project. But this is neither the time nor place to give specific detailed ideas.

It should be obvious why a public relations program is necessary. It could be used in various ways; namely, to allay suspicion of the public regarding food additives and so-called deleterious foods; to improve present publicity with respect to the nutritional values of foods and diets; to bring into proper focus the present and newer science of food processing and of quality control; to increase the prestige dignity and importance of the food technologist—and our Institute. Management would be pleased by the contributions such a program would make in improving their business and industrial standing. Their awareness and sanction of our action would in turn elevate their thinking as to the value of the food technologist to them. Adroitly and diplomatically, we would be supplementing our professional work in business by securing public recognition for ourselves as well as for our employers. The opportunity is present for raising our professional status by our own endeavors.

The American Management Association has formulated and has functioning an excellent program in the technical fields in the past year or two. They saw the opening for an over-all program of assistance in the industrial scientific area and jumped in feet first.

The program of the American Management Association's new Research and Development Division is planned "to help research and engineering executives at all echelons to do a better job in their present positions, and to prepare them for more responsibility; to help individuals and companies obtain optimum effectiveness and productivity from their present research and engineering staffs; to keep management well informed on the latest developments . . . and show what is being done to overcome current problems in all areas of research and engineering programming; to offer both individual executives and companies the chance to participate in a continuous, rewarding interchange of management knowledge and experience."

The Over-all Aim

The over-all aim of this program is to help scientists, engineers, technical personnel, administrators of research and engineering programs—as well as top management—to keep alert and responsive to the rapid progress that American industry is making on every technological frontier . . . help them achieve a better understanding of the management principles that can be applied directly to their specific responsibilities. It is apparent that some of their objectives conform with our own ideas in improving professional status.

Aluminum Foil Packaging– Resistance to Heat and Flame

Report No. 11 of a Series by Reynolds Metals Company

Aluminum foil is unique among flexible packaging materials in its resistance to heat and fire. It does not burn and alloys generally used for packaging do not melt until temperatures reach approximately 1200°F. Aluminum foil also maintains a far higher percentage of its strength at these elevated temperatures than any other flexible packaging material. And the aluminum foil does not become "tacky" or otherwise deteriorate at high temperatures.

These excellent high-temperature properties permit the use of aluminum foil packaging in applications for which other materials are entirely unsuited.

Advantages to Housewife

The housewife was one of the first to recognize the advantages of foil as a nonflammable wrapping and container material. She has learned that foil is valuable not only for wrapping all types of foods for storage in refrigerator and freezer, but also for preparing meals. Since it easily withstands oven and broiler temperatures, the housewife is able to save many hours of tedious kitchen work by wrapping meat and poultry in foil for roasting; by lining broiler pans with foil; by using it as a cookie sheet or as a drip catcher under a juicy pie. She lines baking dishes, too, so she never has to scrub "burned on" food from a casserole.

Package Acceptance

These now commonplace uses thoroughly familiarized the housewife with the heat-resistance of aluminum foil. They pre-conditioned her to the next great step —today's modern foil-packaged "convenience" foods.

This sweeping trend is a direct result of aluminum's heat resistance and nonflammability, and of the housewife's familiarity with foil, which leads her to accept so readily the idea of "cooking right in the package". Naturally, manufacturers and food processors have been quick to grasp the opportunity. Literally thousands of food products are now packaged in aluminum foil containers of all sizes and shapes.

Versatility of Foil

In many cases, the containers are tailored to meet the specific requirements of the particular product. These vary from circular "pie pans" of many different sizes to frozen dinner trays with individual compartments for vegetables and meat. In other cases, cartons are formed of paperboard laminated to light gauge aluminum foil. A large percentage of the prepared cake mixes sold today include disposable aluminum containers in which housewives can bake their cakes. And many food items are now appearing in heat-sealed foil envelopes which can be heated for serving by merely placing in a pot of hot or even boiling water.

Minimizes Cooking Chores

In every one of the above cases—whether the contents are frozen or not—the aluminum foil package provides a disposable container in which the food is prepared and often served without soiling utensils or dishes. Whether the heating or cooking is done in the oven, on the range or in boiling water, all of this is possible because of the heat resistance and nonflammability of aluminum foil. Yet this is only one of the many valuable characteristics of aluminum foil which make it outstanding for your packaging needs.

If you have a high temperature problem with your product, your local Reynolds representative will be glad to help you solve your packaging problems. Or you may write **Reynolds Metals Company,** General Sales Office, Louisville 1, Kentucky.

Watch Reynolds all-family television program "Disneyland", ABC-TV.

Open new markets with the help of EASTMAN antioxidants

Ever develop a food product which could be given only local distribution—or perhaps couldn't be marketed at all—because of limited stability? If so, it probably contained an oxygen-sensitive ingredient, such as an oil or a fat, which caused the trouble.

Let Eastman help you combat this problem with its complete line of Tenox antioxidants. Our staff of food technologists would welcome the opportunity of working with you on the proper use of these antioxidants. Assisting other food processors in this manner, we have helped send many fine products from the laboratory shelves to the market place.

Since Eastman manufactures the widest range of antioxidants, we have no axe to grind in favor of any one. You can be certain our recommendation will represent the most economical and effective stabilization possible against oxidative deterioration.

For more information about Tenox, write to Eastman Chemical Products, Inc., Kingsport, Tennessee—a subsidiary of Eastman Kodak Company.

Tenox Eastman food-grade antioxidants

A few weeks ago, in Chicago, I attended a two-day meeting of the National Industrial Research Conference sponsored by the Armour Research Foundation. The program was an excellent one, but I was most impressed by the large number of top executives in attendance—presidents, vice presidents, directors of research, plant managers and superintendents—all from large corporations. They not only appeared as speakers but also as listeners. They were, I am sure, duly impressed with the importance of research to their companies and the highly regarded status their technologists and scientists occupied. The meeting was tremendously successful in improving the standing of professional employees—just by inferences as to what they do and how they manage it.

The Manufacturing Chemists Association is also an important factor in improving relations for their members and with the public, and there are others.

Dr. Dael Wolfle, in *Science* (February 1, 1957), wrote, "The new problem is this: Science has become so abstract and complex, and is changing so rapidly, that it has become extremely difficult for the non-scientist to understand. At the same time, science has assumed such a fundamentally important role in our industrial and technological society, that it becomes extremely important for the non-scientist to understand its nature and the role it plays in our culture and our economy." Statements of this sort by outstanding scientists are not unusual and are becoming more frequent. They imply the fact that scientists and technologists have disregarded and are disregarding a proper communication with the public to their own detriment.

We should feel encouraged by the progress that has been so noticeable recently in the improvement of professional status. Management has become increasingly concerned regarding certain inequities existing in the technological areas, such as classifications of scientists and technologists, promotions, salaries, permanency, retirement benefits, over-age employment, proper utilization of skills, plant education, human relations, etc. Management's interest in our behalf should result in mutual benefits; for happier employees are more efficient, more loyal and more reliable, and any attempt at collective bargaining for scientists would quite probably be essentially rejected. Specifically, in the areas I have mentioned, there remains much to be done and we can ill afford to be indolent or indifferent in our efforts for improving our professional status.

In this discussion, I trust some food for thought and action has been clearly indicated. Improving the status of our members can be an important project for our strong, vibrant, and highly intelligent Institute. How we do it may be a controversial matter. That such a project would provide opportunities for encouraging our younger members and our future members, supply new interest, and stimulate progress should be apparent to all of us. This is sufficient reason for the *why* of the ambiguous title of my discussion, "The Time Has Come."

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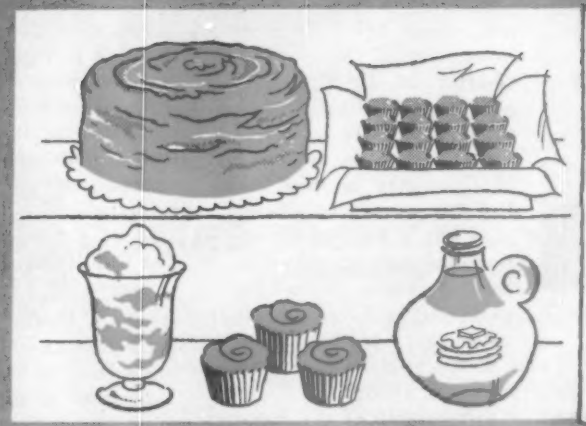

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The Professional Society As A "Pro" Maker

Sidney W. F. Hanson

British Joint Services Mission, British Embassy, Washington, D.C.

I FEEL I should preface this short talk* with the comment that what I have to say is by no means intended to be a recommendation to the Institute of Food Technologists on how to run its affairs. I am, rather, going to tell you a little about how another professional organization, with much the same objectives, has developed. It has not been too easy to put this story into simple form, for in response to the pressures of the day the regulations have been amended within recent months, after much deliberation and debate. The Royal Institute of Chemistry has been looking after the interests of all sorts of chemists, and jealously guarding the standards of the profession, since 1877. It was incorporated by Royal Charter in 1885, and a new Royal Charter was granted in 1949, as a result of which the Institute of Chemistry became the Royal Institute of Chemistry. It is the qualifying professional organisation for chemists, including those engaged in the advancement, teaching and practice of chemistry, and in the application of the science in industry and the public service.

Sidney W. F. Hanson

There are four grades of membership of the Institute. Two of these, Student Membership and Graduate Membership, are transitional non-corporate grades leading to corporate membership, which also comprises two grades—Associateship and Fellowship.

Corporate membership is open only to persons who have produced evidence of adequate training, knowledge, skill and experience as chemists and who undertake to conduct themselves honourably in the practice of the profession. The Associateship is the basic professional qualification in chemistry and the Fellowship is the senior grade to which those with more mature experience and responsibility may aspire.

Under the provisions of the Royal Charter an Associate is entitled to use after his name the initials A. R. I. C., and a Fellow the initials F. R. I. C. as an indication of his professional qualifications and standing.

These qualifications are recognized by public authorities and by industrial, educational and other employing bodies as representing high standards of professional attainment. Diplomas in certain branches of applied chemistry, awarded by the Institute, have special significance in relation to corresponding fields of work. Thus appointment as a Public Analyst is dependent upon having obtained a diploma on the results of an examination in the appropriate branch of applied chemistry—the Chemistry (including Microscopy) of Food, Drugs and Water.

For senior appointments in other fields of public service, e.g., as clinical biochemists in hospitals and as chemists in water and sewage undertakings, diplomas in the relevant branches are becoming increasingly important. The great majority of corporate members (and there are some 5,000 Fellows and 10,000 Associates), however, are engaged in research, development or control laboratories in industry, both private and nationalised, or the government; or in teaching in universities, technical colleges and secondary schools. An increasing number are occupying posts involving special responsibilities, as directors of industrial firms, government establishments or research associations, managers of factories or principals of educational institutions.

The Qualifying Process

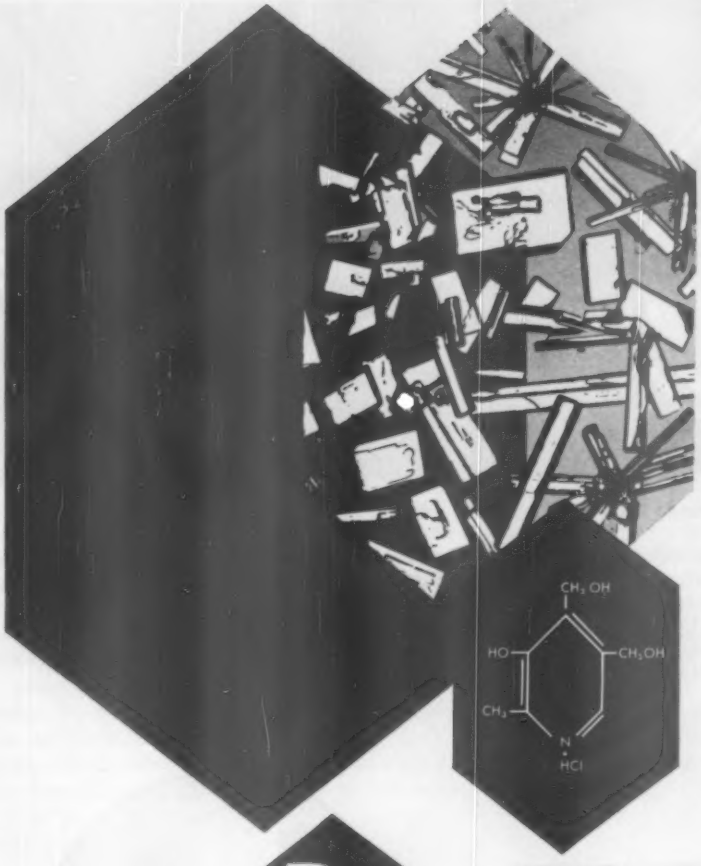
Now, how does a boy (or girl) reach such dizzy heights? First, the prospective chemist must have a good general education. He is expected, before leaving school, to have obtained a General Certificate of Education at the ordinary level in at least English language, mathematics and three other subjects. (This is the level of the old Matriculation or university entrance examination, taken at about 16, after about 12 years of schooling.)

The next step is to take the General Certificate at Advanced Level in Chemistry and appropriate auxiliary subjects; which he can do by staying at school for another couple of years, or by taking an Intermediate Degree at a University, or by taking National Certificates at night school or other part-time course. Then he may apply for Student Membership of the Royal Institute of Chemistry, and commence a professional course of study.

The Institute recommends that in general the study of chemistry, including the necessary practical training, should be pursued in a full-time course at a University or other recognized institution. Part-time study at a recognized technical college, involving evening work and usually daily employment in industry, is an alternative though harder and longer route that many have followed successfully.

Another possibility, which is now emerging in some places and is approved by the Institute, is the

* Presented at the Industry and Education Session, Seventeenth Annual Meeting of the Institute of Food Technologists, Pittsburgh, May 14, 1957.



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"Sandwich Course," in which the student spends, over a number of years, alternate periods of several months in full-time study at a technical college and in full-time industrial employment.

In order to ensure a broadly based and balanced training, at least three auxiliary subjects have to be taken to the level of a University Intermediate Science examination. Physics and mathematics are obligatory, but a wide range of choice of other subjects, including arts subjects, is available.

Upholder of Professional Standards

At this point I feel I ought to stress that the Royal Institute of Chemistry is an examining body. This is deemed essential to its position as upholder of the standards of the profession. Its influence, which even bears upon pay and conditions of service, are predicated upon the high status of its members, resulting from the Institute's overwhelming concentration on education and training. In the sense that students take courses to pass its examinations it has a powerful influence on the teaching institutions, but it does not deign to impose a syllabus or to approve directly the programme of any college or university. Any attempt to do so would, I imagine, be dealt with in summary fashion.

Before admission as a Graduate Member the student must have passed, or been exempted from, both Part I and Part II of the Institute's examination. Part I is approximately of university Bachelor of Science degree level in chemistry and Part II, which includes an extensive practical examination, is equivalent to a good honours degree. Exemption from the whole examination is granted to graduates of universities in Great Britain and Ireland with first or second class honours degrees in chemistry.

Having completed his formal examinations and attained to Graduate Membership, the chemist must now obtain at least two years of approved experience before he can be admitted to corporate membership as an Associate. The character of the experience may be of various kinds, but the applicant must show that he has been able to apply his knowledge in some field of activity (such as research, teaching or industry) involving personal initiative and responsibility for the soundness and reliability of his work.

I might mention that in 1956, 770 candidates applied for Graduate and Associate Membership; 184 succeeded.

The senior grade of corporate membership, the Fellowship, is open to well qualified chemists of established repute who have attained a suitable level of professional maturity (at least 5 years after Associateship) and responsibility in any field that promotes the advancement or wider application of chemical science.

THE TECHNICAL ARTICLES IN BRIEF

Continued from page 1

however, results in many disadvantages—such as the development of undesirable flavor, interference with aging, and formation of precipitates and turbidity.

Previous investigation by the authors showed that at 7 p.p.m., Vitamin K_5 is effective in preventing secondary fermentation in light sweet wines.

Present work was done using Vitamin K_5 as preservative in controlling the development of volatile acids. Results showed that K_5 was not nearly as effective in controlling the development of volatile acids as it was in controlling secondary fermentation. Concentrations as high as 50 p.p.m. did not completely stop the development of volatile acids.

Microbiological studies showed that K_5 was very effective in killing *Saccharomyces ellipsoideus*. Small concentrations of K_5 have shown nearly 100% effectiveness. (See page 536)

Antibiotics *Vegetables*

Delaying vegetable spoilage with antibiotics. V. J. Carroll, R. A. Benedict and C. L. Wrenshall.

Solutions of oxytetracycline hydrochloride, streptomycin sulfate and polymyxin B sulfate were tested for decay control in six vegetables. Only oxytetracycline gave good control of spoilage. Oxytetracycline controlled spoilage up to 48 hours at 30° C. Longer delay of decay development was obtained with oxytetracycline at 5° C. and 10° C. Streptomycin was the second most effective antibiotic treatment. Polymyxin was least effective. Rate of decay was measured by visual inspection, volume of exudate, bacterial counts of the exudate and odor. (See page 490)

Instrumentation *Granular products*

Control of moisture in granular products. Wm. J. Scarlett.

Control of moisture in many granular products has presented a problem for a considerable time. A means has been found to do this automatically and continuously in at least one product. It is assumed that the extension of the technic employed to other products can be readily accomplished. This will pave the way for the application of automatic control to many food processing operations.

The means which have been used in several successful applications are pointed out. Results, performance, and the resulting improvement in product are documented. Not only is product quality improved and made more uniform, but the method also smooths out or eliminates some

troublesome production problems. With proper evaluation of fundamental information obtainable by this method the way to the probable solution of many difficult process problems is indicated. (See page 532)

Heat processing *Cucumber slices*

Effects of jar size, liquor, and product-to-liquor ratio on heating characteristics of fresh-packed pickle products. R. C. Nicholas, I. J. Pflug, and R. N. Costilow.

Heating rate, lag factor, and sterilizing value have been determined for controlled packs of cucumber slices and spears in jars with different geometries and with different liquors. Effects of jar size and liquor on the different packs are presented in tabular form. In general, a product in syrup heats more slowly than the same product packed in brine. Increasing the product-to-liquor ratio, while it does not significantly change the rate at which the jar heats, does increase the lag factor; the net result is a decrease in the sterilizing value. (See page 488)

Stability *Frozen concentrated orange juice*

Stability of frozen concentrated orange juice. IV. Effect of variety and maturity on heat treatment required. O. W. Bissett, M. K. Veldhuis, R. B. Guyer, and W. M. Miller.

Concentrates from heat treated Hamlin, Pineapple and Valencia orange juices were examined for PE activity, cloud stability, and flavor. With each variety tested, heat treatments at 150° and 160° F. inactivated a lesser percentage of the enzyme with advancing maturity. There was little effect of maturity on the percentage of enzyme inactivation for the juices heated at 170° and 180° F.

Cloud stability was greatest in both heated and unheated juices of the Valencia variety and least in that of the Hamlin. Cloud stability was attained for Valencia concentrates at lower heat treatment temperatures than for the other two varieties. Differences in cloud stability resulting from differences in time of harvest were less than the differences betwen the three varieties.

No effect of heat treatment on flavor of the products was observed in the Hamlin or Valencia concentrates; however, a significant difference was observed in the Pineapple products packed in March which had received heat treatments of 170° and 180° F. The Hamlin concentrates packed in late December were flat and low in flavor while Valencia products processed in May and June were superior to those of earlier packs. (See page 512)

Stability *Frozen concentrated orange juice*

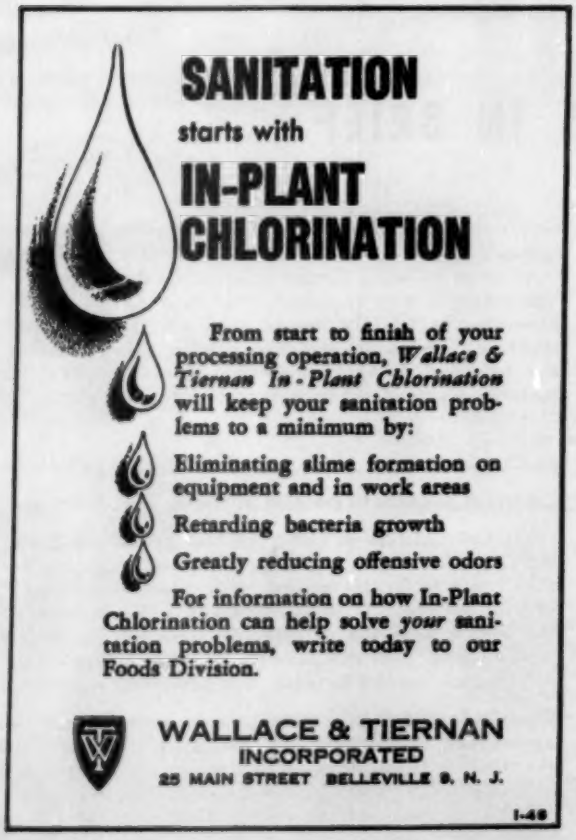
Stability of frozen concentrated orange juice. V. The effect of heat treatments on juices prepared from Valencia oranges. E. A. Carroll, R. B. Guyer, O. W. Bissett, and M. K. Veldhuis.

Over a 3-year period, studies were made on the effect of heat treatment at several stages of concentration on cloud stability, flavor, and pectinesterase activity of frozen concentrated orange juice made from Valencia oranges. In the first season's study, heat treatments of 140, 160, 180, and 200° F. were applied to single strength juice and at concentrations of 22°, 42°, and 55° Brix. In the second and third season's work, heat treatments of 150, 160, 170, and 180° F. were applied to single strength juice and concentrates of 20°, 26°, 32°, and 38° Brix.

From the standpoint of pectinesterase inactivation, no significant difference was noted between the intermediate concentrations under study at any specific heat treatment, but it was shown that inactivation was less effective with single strength juice than it was at the intermediate stages of concentration.

With respect to cloud stability, heat treatment at 140° F. was ineffective at all concentrations, and no advantage was demonstrated for 200° F. over that above 180° F. treatment. In the first two seasons' work, all products heated in the range of 150 to 180° F. at intermediate concentrations remained stable at 40° F. for the normal observation period of 6 weeks while treatment of single strength juices was less effective particularly at the lower temperatures. In the third season's work, cloud stability was markedly different, primarily due to equipment modifications, effected to produce juice more nearly representative of commercial operations. A more rapid loss of cloud was noted in all samples, but the advantage of treatment at intermediate concentrations was more pronounced. There was a slight increase in effectiveness of heat treatment with increased concentration at which the treatment was applied.

No differences in flavor were noted in the products prepared in the first and second seasons' work, but in the third season's work, there was a significant difference (1% level), although not objectionable, between controls and products heat treated at 180° F. (See page 516)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Stability — *Frozen peas*

Effect of maturity and storage temperature on quality of frozen peas. W. C. Dietrich, F. E. Lindquist, and Mildred M. Boggs.

Storage stability studies are reported for Thomas Laxton peas at 3 maturity levels for two harvest seasons. Samples were stored at −30, −10, 0, and 10° F. for several time intervals from 0 to 69 weeks. Changes in ascorbic acid and flavor and color scores were observed. Small and immature peas were found to be more susceptible to deterioration than the large and more mature peas. (See page 485)

Inspection

Sampling plans, fruits and vegetables

Sampling plans developed by United States Department of Agriculture for inspection of processed fruits and vegetables. Richard P. Bartlett, Jr. and John B. Wegener.

In developing a sampling acceptance plan by *attributes*, the first point is that no sampling plan can guarantee that the portion of the product not inspected will possess equal or better quality than that of the sample. Every sampling acceptance plan involves a "chance" of accepting some defective or inferior quality product in the lot. Therefore, on the basis of expert knowledge of the product to be sampled, it must be decided what percent defective product would be acceptable in the lot. This percentage is often called Acceptable Quality Level (AQL). Sometimes it may be desirable to classify defective product according to the severity of the defects. For example, one might define two types of defects, major and minor, and specify that any sample unit possessing minor defects only is a minor defective of which one is willing to accept, say, 5% in the lot. Those units possessing major defects only—or both major and minor defects—will be major defectives, of which one will accept, say, 1% in the lot.

Once the AQL's have been established, the buyer's and seller's risks must be determind. The buyer's risk may be defined as the percentage of time that lots are accepted which are worse than the AQL or the AQL + X percent. The seller's risk is the percentage of time that lots are rejected which are equal to, or better than, the AQL. These decisions form the basis for a formal sampling plan. To establish the lot-by-lot acceptance plan by *attributes* only three numbers are needed:

1. N, the lot size
2. n, the sample size and
3. c, the acceptance number (i.e. the maximum number of defectives or defects permitted in an acceptable sample). (See page 526)

Packaging — *Prepackaged meat*

Factors affecting quality of prepackaged meat. II. Color studies. A. Effect of package characteristics upon color of product. John A. Rikert, C. Olin Ball, and Elizabeth F. Stier.

Cellophane-acetate-pliofilm laminate was shown to be one of the best packaging materials for maintaining good color in cut and in ground samples of lamb (7 to 12 days' storage). Vinyldene copolymer was the best for packaging lean ground beef to retain color and cellulose acetate the best for fat ground beef. Cellophane-pliofilm laminate proved best for color retention in ground lean and fat pork. Results apply to the criterion of color only. (See page 520)

"Auto-mersion" freezing may go to sea

Glycerine in immersion freezing processes can provide important advantages for fast automatic freezing. Adapted to commerical fishing vessels, such "automersion" may well enable the fisherman to preserve fish within minutes of the time of catch.

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Of Professional Interest

Results of Russian Research to Be Made Available

Pergamon Institute (Non-Profit Foundation) Set Up to Serve English-Speaking Scientists[a]

PERGAMON INSTITUTE, a non-profit-making foundation recently formed in New York and in course of formation in London, proposes to make available to English-speaking scientists, doctors and engineers from all countries that are members of the United Nations, the results of scientific, technological and medical research and development in the Soviet Union and other countries in the Soviet orbit. Over a hundred scientists of international standing from many countries have given their support and will supervise the affairs of the Institute.

Formation and purpose of the Institute were much influenced by a report[b] to the United Kingdom Government by its Advisory Council on Scientific Policy, under the chairmanship of Sir Alexander Todd, F. R. S., which, among other things, analysed the position as follows: " . . . There would of course be no problem if Russian were widely read, but our information is that only about 2% of our working scientists can read Russian, compared with 80 to 90% who read French, and 60% German. The first thing to be done, therefore, is to encourage the teaching of Russian as an important modern language in schools and universities. . . . The evidence suggests that there must be at least a thousand current Russian scientific and technical periodicals. . . . Apparently, over 14,000 scientific and technical books were published in Russian in 1954. But at present the British Museum is only receiving about 800 a year, the D.S.I.R. 300, and the 170 libraries referred to (above) have less than 1,000. . . . Evidently therefore this country is only receiving a fraction of the output of Russian scientific and technical literature. . . . It is important that it should be easy to trace any available Russian scientific and technical literature and that the existence of such literature should be widely known. The normal way of achieving this is through scientific abstracts. But, while some Russian journals are already abstracted in Western countries, it seems clear that this service is uneven and inadequate. We therefore regard the development of an effective system of abstracts, or summaries, of Russian scientific and technical journals (as far as possible by expanding the existing services) as an urgent matter. A 'Literature Information Unit' might be necessary, to complement the work of the abstracting services by making known what exists, and where. . . . Careful consideration of the different aspects of the Russian problem is extremely urgent, if we are to keep abreast of this Russian literature, and also if we are to avoid the emergence of a number of partial and unsatisfactory solutions of the type which proves a barrier to subsequent progress."

AIMS AND PURPOSE OF THE INSTITUTE

I. To establish a Translation Panel of competent and highly qualified translators from Russian and other Slavonic languages into English; and to make available the services of the Institute and its Translation Panel to scientists, learned societies, government agencies and industry throughout the world on a non-profit making basis. The Institute shall charge its customers for these services on a co-operative cost-sharing plan.

II. To encourage, co-ordinate and foster (by the holding of Symposia, for instance) the teaching of Russian at higher seats of learning; and to provide the teaching institutions with the necessary textbooks and tools of learning which will enable non-Russian speaking scientists to acquire quickly a working knowledge of Russian sufficient for them to read Russian scientific literature.

III. To translate and disseminate such of the scientific, technical and medical literature printed in Russian and other Slavonic languages, which, in the opinion of competent scientific advisors, will be of definite benefit and value to scientists not speaking these languages.

[a] Excerpted from information addressed to the President, Institute of Food Technologists, and supplied by Captain I. R. Maxwell, Director, Pergamon Institute. President of Pergamon Institute is Sir Robert Robinson, Professor of Chemistry, Oxford University, who is also President of the British Association for the Advancement of Science.

[b] November, 1956.

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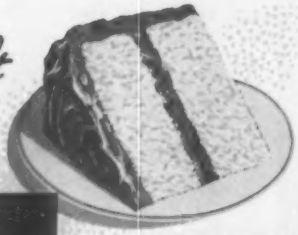

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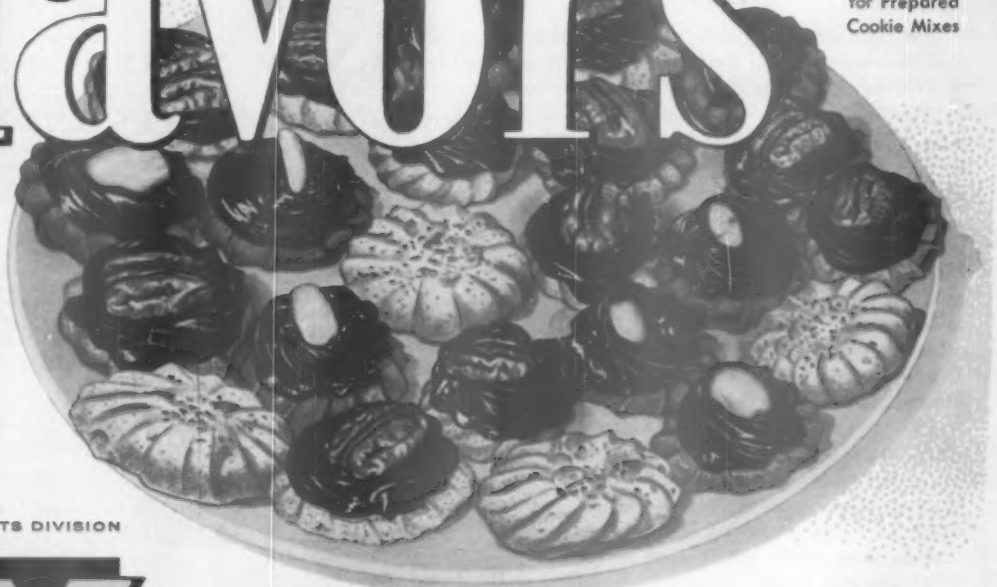

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IV. To establish and publish, with the assistance of the appropriate scientific institutions in the U.S.S.R. a series of monographs in the English language reviewing progress in broad areas of Soviet scientific activity.

V. A. To publish a journal devoted to reporting translation work done anywhere in the world from Russian and other Slavonic languages into English in the fields of science, technology and medicine in order to prevent duplication.

B. To serve as a forum in which Soviet and non-Russian speaking scientists will be able to discuss problems of common concern—both scientific and administrative.

C. To be a place where people engaged in the teaching of Russian to non-Russian speaking scientists can report on their experience and exchange information which will be of assistance to persons working in this field.

VI. To compile and publish specialised dictionaries from and into Russian and the principal Slavonic languages for subjects where such dictionaries are lacking.

VII. To sponsor and foster research into the organisation of scientific information, mechanical systems for storing and retrieving information, and mechanical translation.

VIII. To assist and advise learned societies and professional bodies on their publication problems with a view to reducing the cost of printing and distribution of their publications in the interests of the wider and more efficient dissemination of scientific information.

SERVICES

Institute services will be made available to learned societies, Government departments, trade associations, individual scientists, doctors and engineers.

1. Any person in the above categories wishing to keep informed of what is being published in the U. S. S. R. and other countries in the Soviet orbit may apply to the Institute to receive, free of charge, a monthly contents list in English of all the significant articles and books being currently published in his field of interest in these countries. Persons interested in any article mentioned in these lists may order from the Institute a full English translation which will be supplied with a minimum of delay. Charge for such a translation will be on a co-operative cost-sharing basis. This means that the costs will be shared equally with others requesting the article. Costs will be assessed on orders obtained for this translation over a period of 6 months, and the charges to recipients of these papers will be made 6 months after the first request. Maximum charge for these translations shall not exceed £1.10.0. ($4.00) per 1000 Russian words.

2. The Institute will undertake to supply, on request, detailed and exhaustive bibliographical information on work published in the U. S. S. R. and other Soviet orbit countries on all subjects in the field of science, technology and medicine; such services will be quoted for and charged at cost.

3. The Institute will undertake, on request, to evaluate work published in the fields of science, technology and medicine in the U. S. S. R. and other Soviet orbit countries. The Institute will also be able to provide abstracts and resumés of such publications.

4. The Institute will provide, with the co-operation of the respective National Academies of Sciences in the U. S. S. R. and other Soviet orbit countries, to learned societies, Government departments and industrial organizations only, for the purpose of research and reference, books and journals published in the U. S. S. R. and the Soviet orbit countries, including micro-cards and micro-films when available of books and articles published over the past 20 years in these countries, including material published during the 1939-1945 war as far as available.

5. The Institute will undertake the complete translation of selected journals and books if suitably recommended by learned societies, Government departments or trade associations.

6. The Institute can undertake, with the aid of its expert panel of translators, resident all over the world, translation work in all branches of science, technology and medicine from and into any language, including Chinese and Japanese.

7. The Institute will make available to learned societies and individual scientists, doctors and engineers in the U. S. S. R. and the other Soviet orbit countries reciprocal services on the same non-profit making basis in return for their co-operation.

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Awards, Honors, and Fellowship in Food Science and Technology

THE EXECUTIVE COMMITTEE of the IFT Council and the Institute Awards Committee have provided a checklist of the Institute-administered awards, honors, fellowships and scholarships. The hard, conscientious work of the Awards Committees of recent years has yielded an excellent administrative system for selecting the awardees, handling the paper work, and presenting the various honors and the accompanying stipends or honorariums.

That IFT now has in good working order a system of awards that covers most of the areas of professional interest is evident. Also in evidence is the fact that the Fellows and Scholars now coming out of their college work and into professional life are worthy of the honor that has been bestowed upon them. That they will contribute to research, engineering, and development progress in the food field is to be anticipated with confidence. The donors and the Institute can also take satisfaction in their having recognized with appropriate awards the contributions of scientists and technologists now in practice, the great men of a great and growing sphere of technical endeavor.

Fellowships and scholarships in Food Technology and Science deserve particular notice. To undergraduate and graduate students interested in vocations in the sciences and technologies that relate to food there should be encouragement in the generous stipends made available by the several donors.

AWARDS

Babcock-Hart Award

DONOR: Nutrition Foundation, Inc.

AWARD: $1,000.00 and an engrossed plaque.

PURPOSE: To honor a person who has distinguished himself or herself by contributions to Food Technology which have resulted in improved public health through some aspect of nutrition or more nutritious food.

Institute of Food Technologists International Award

DONOR: Australia Regional Sections of the Institute.

AWARD: A suitably engraved Silver Salver.

PURPOSE: To promote the international exchange of ideas in the field of Food Technology. Award shall be made annually to a member of the Institute of Food Technologists who has made outstanding efforts to promote the international exchange of ideas in the field of Food Technology or whose work has led to such exchange of ideas or to better international understanding in this field.

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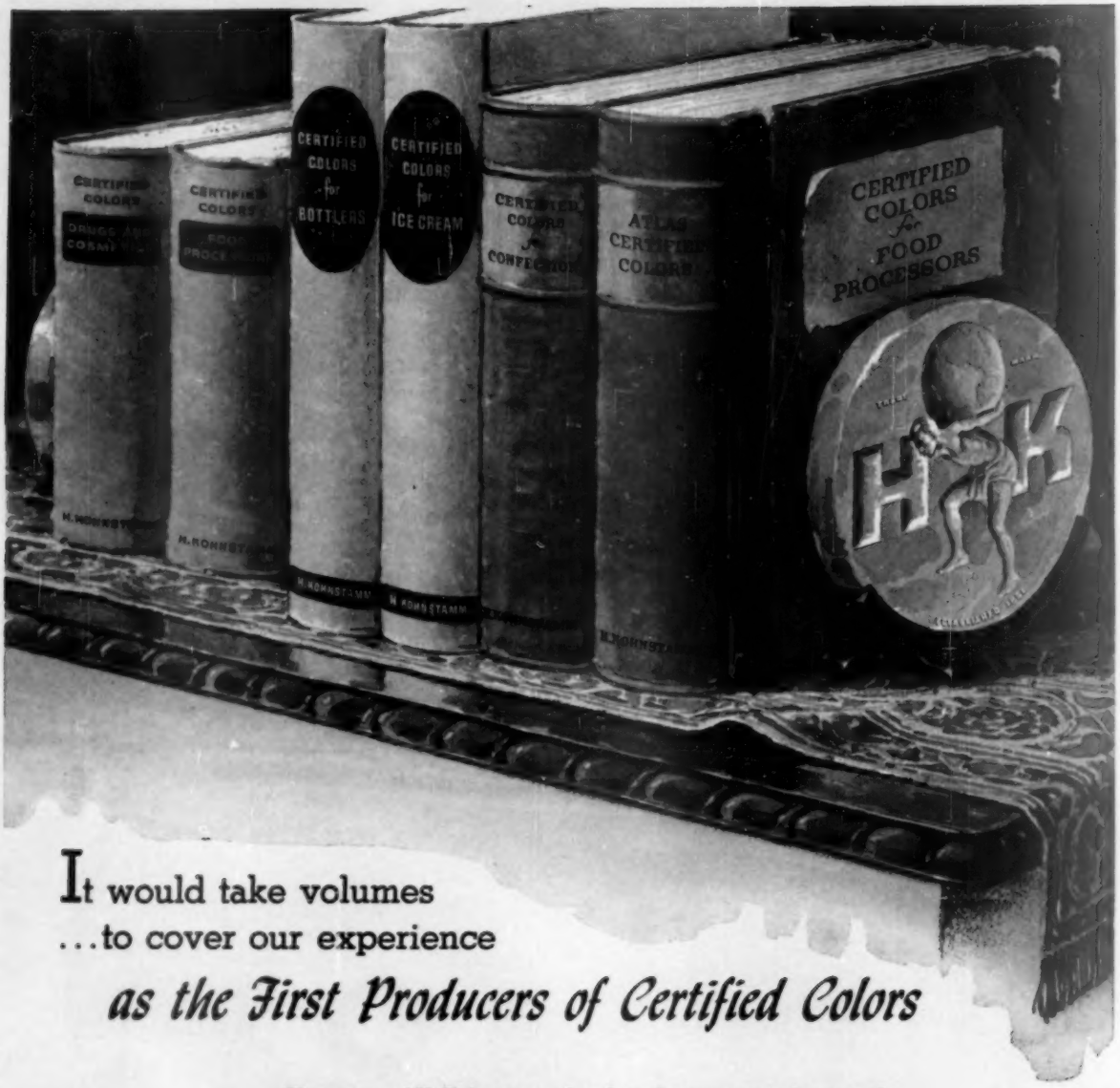

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AWARD: This Award, originated by the Chicago Section of the Institute of Food Technologists, consists of a Bronze Medal (furnished by the Chicago Section) and an honorarium of $1,000.00.

PURPOSE: To honor a person for pre-eminence in and contributions to the field of Food Technology.

Institute of American Poultry Industries Award

DONOR: Institute of American Poultry Industries.

AWARD: $1,000 from the donor and an engrossed plaque.

PURPOSE: To stimulate and reward research in the field of poultry and egg processing and marketing, such research to contribute to increased consumption of these products or related products. *Or*, to honor outstanding contributions in fields closely related to the interests exemplified by the Institute of American Poultry Industries.

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Florasynth Fellowship

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AWARD: $1,000.00—For the academic year payable $100.00 per month for 8 months and $200.00 one month, and an engrossed plaque furnished by the Institute.

PURPOSE: To encourage graduate work in the field of food science.

NOMINATIONS: Nominations for the fellowship shall be made by the Head of the Department who supervises the work of the Candidate. Nomination shall be in letter form and give the following information regarding the nominee:

Name and mailing address; nationality; sex, age and marital status; a small photograph of the applicant.

College or university academic record in transcript. (In addition to the official transcript, submit a typewritten summary listing in detail all subjects pursued and grades attained.)

Noteworthy scholastic or research accomplishments.

Justification for proposing the candidate (in complete detail) including a statement as to need, if any, for financial assistance.

Candidate must have a better-than-average scholastic record and/or a B.Sc. or equivalent, preferably with honor, from an institution of recognized standing.

Nominations must be received not later than February 1st. They should be sent to the Executive Secretary, IFT, 176 W. Adams St., Chicago, Ill.

GENERAL CONDITIONS: The fellowship will be granted annually to a young man or woman who is:

a citizen of the U. S. or Canada under 35 years of age;

a senior undergraduate or one engaged in graduate work for an advanced degree at a recognized educational institution in the U. S. or Canada which is conducting fundamental investigations for the advancement of Food Technology;

a person of outstanding qualities of character and personality, and a demonstrated scientific or engineering aptitude together with an above average interest in research.

Award shall be made to a person in a different institution each year, except that after 3 years, the Award may again be made to a person in an institution where it was previously held.

General Foods Fellowships

DONOR: The General Foods Fund, Inc.

Award: Three fellowships at $4,000.00 each and an engrossed plaque furnished by the Institute. Fellowships shall be for a full calendar year. The Fellow shall receive a minimum of $200.00 per month for 12 months, the remaining $1,600.00 to be used to pay all academic fees of the fellow with the proviso that any remaining moneys accrue to the department fund of the department wherein the Fellow is working, to be used at the discretion of the Department Head. This portion of the Award may be used for direct research expense including travel by the fellow. If the Department Head so elects, all or a portion may be used to increase the payments to the Fellow. Disposition of this portion of the Award shall be determined by conference between the Department Head, the Fellow, and the Executive Secretary of the Institute of Food Technologists.

Fellowships will be granted annually—no more than two to the same educational institution for the same calendar year—but will be renewable upon application to and approval by the Awards Jury for a maximum of 3 years, in order to provide for continuity of studies leading to a doctorate degree, if the candidate so plans. However, candidates, who plan only a year of research after obtaining the Bachelor Degree, or who plan to study for a Master's Degree, will not be excluded.

Awards will be made to deserving and outstanding United States or Canadian citizens, engaged in senior undergraduate or graduate work in

recognized educational or research institutions in the United States of America or Canada, in basic or applied chemistry, chemical engineering or related sciences, which may involve new physical or other procedures, directed to extending or improving knowledge in some phase of food conservation, food production or food processing, rather than primarily for research in the fields of nutrition, bacteriology or analytical chemistry.

In order to qualify, an applicant must be a senior undergraduate student, with better than average scholastic record at an institution of recognized standing; or, a graduate student with a B.Sc. or equivalent, preferably with honors, from an institution of recognized standing.

PURPOSE: To encourage graduate work in the field of food science.

APPLICATIONS: Applications must be sent to the Executive Secretary of the Institute, 176 W. Adams St., Chicago 3, Ill., to arrive not later than February 1 and shall be in letter form, giving the following essential personal and academic information with respect to the applicant:

Name, nationality, sex and age, marital status; a small photograph of the applicant.

A physician's statement with respect to the general health and physical condition of the applicant.

College or university academic record in transcript. (In addition to the official transcript, the applicant shall submit a typewritten summary listing in detail all subjects pursued and grades attained).

List of notworthy accomplishments, if any, in research.

Purpose of the applicant in applying for the Fellowship (such as to complete work for Master's or Ph.D. degree, or to carry out a specific research project).

Experience background. (Describe work experience during, prior or subsequent to college).

Applicant must submit 3 letters of recommendation from Deans, Heads of Department and/or Professors, who have supervised academic work of the applicant. These letters should present essential facts regarding scholarship record, character and personality, ability to cooperate, and capacity for work and achievement of the applicant.

Each application shall be accompanied by a letter from the Head of the Department where applicant proposes to do his work, accepting for the school responsibility connected with the fellowship and stating that the Fellow is acceptable to his department.

Samuel Cate Prescott Fellowship

DONOR: Institute of Food Technologists.

AWARD: An honorarium of $1,000.00 and an engrossed plaque. Honorarium is payable $500.00 upon receipt of evidence of registration in graduate work and $500.00 at the beginning of the following semester. In addition, the Institute will defray the expenses of the awardee to attend the Annual Meeting in an amount not to exceed $400.00.

PURPOSE: To encourage graduate work in the field of food science and food technology.

GENERAL CONDITIONS: Award to be made annually to an outstanding young man or woman of any nationality engaged in senior undergraduate or first year graduate work in the general field of food science and food technology, at a recognized educational or research institution in the United States or Canada. Award shall be for one year only and is not renewable.

APPLICATIONS: Applications must be sent to the Executive Secretary of the Institute to arrive not later than February 1st. They shall be in letter form giving personal and academic information concerning applicant, namely:

Name, age, and sex; marital status.

Transcript of college or university academic records (in addition to the official transcript, applicant must submit a typewritten summary of transcript listing in detail subjects pursued and grades attained.)

Extracurricular activities, hobbies.

Special achievements and honors.

Work experience, if any, during, prior, or subsequent to college.

Purpose in applying for award (working toward advanced degree or to pursue a specific investigation, etc.) Describe fully.

Statement by applicant on his or her word of honor to carry through with intended course of study or research.

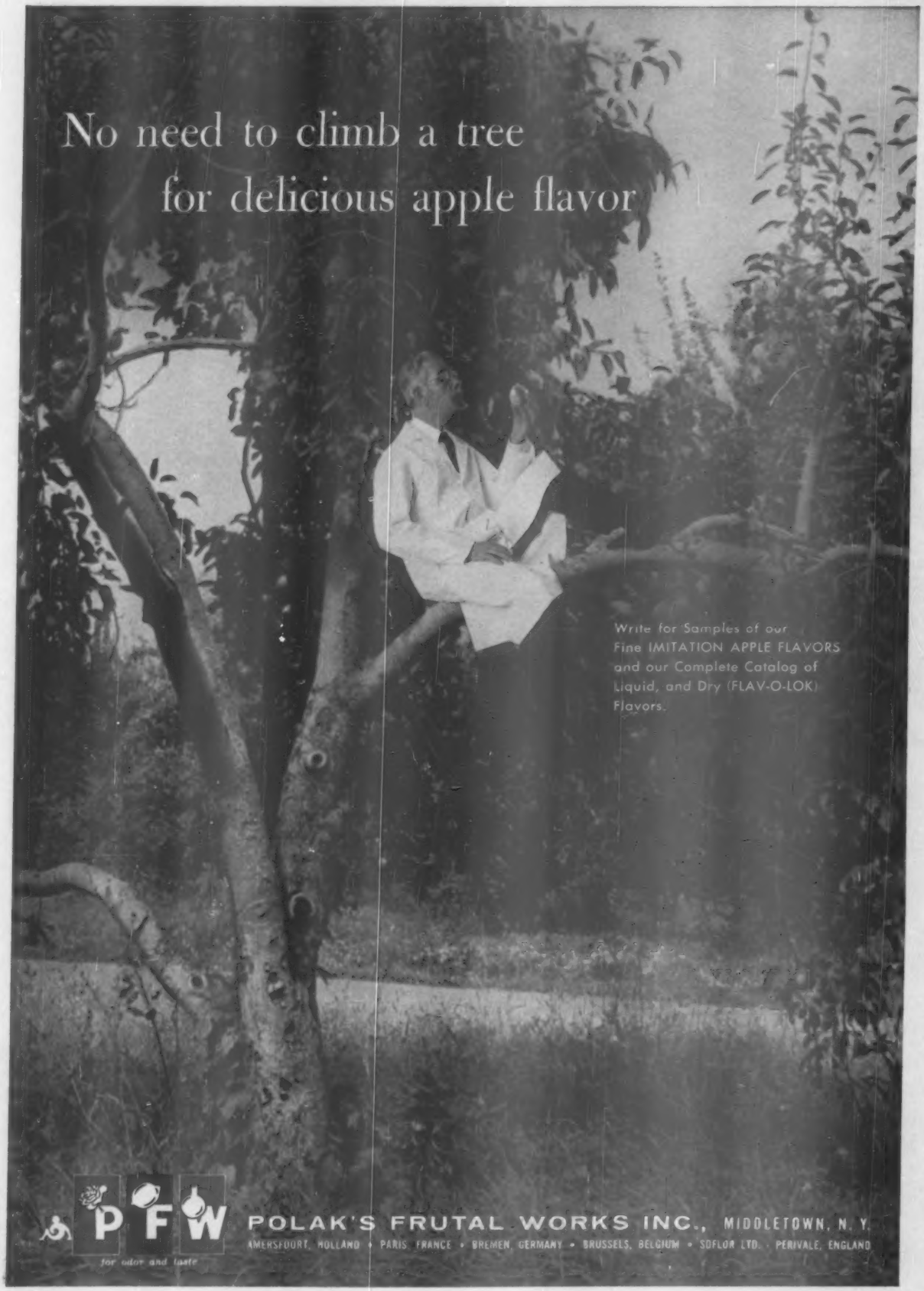
A letter of recommendation from Head of Department where applicant has pursued his or her major studies. This letter must present essential facts with respect to character and personality, ability to cooperate, capacity for work and achievement, and scholarship of applicant.

Gerber Baby Foods Scholarships

DONOR: Gerber Baby Foods Fund, Inc.

AWARD: Six (6) Undergraduate Scholarships at $1,000.00 each, per year and an engrossed plaque. Scholarship shall be for one school year of 9 months. The student shall receive $100.00 per month for 9 months and the additional $100.00 shall be payable to student at his election any time during the school year. Awards are intended to cover the last two school years leading to a Bachelor's Degree in Food Technology,

(Continued on page 38 following technical papers)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One of several steps in reducing thick slabs of steel to the thin-gage strip needed for producing tinplate is cold rolling. Cold reduction, however, tends to make the resulting steel strip hard. In order to regain the steel's workability, it must go through a "softening" process called annealing.

In continuous line annealing, great coils of full hard strip are passed, in single thicknesses, through a series of vertical passes within a furnace. The furnace has heating, holding and cooling zones. Within seconds, the temperature of the steel strip is brought up to a sub-critical temperature near 1200° F. Within three minutes of the time it went into the furnace, the steel is back to just above room temperature. A reducing atmosphere is maintained in both the heating and cooling zones to prevent oxidation—thus maintaining the strip's relatively bright surface throughout. The annealing process assures optimum condition of the steel for further processing. Once annealed, the stresses and hardness caused by cold reduction are relieved.

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Effect of Maturity and Storage Temperature on Quality of Frozen Peas

W. C. Dietrich, F. E. Lindquist, and Mildred M. Boggs

Western Regional Research Laboratory,[a] Albany, Calif.

(Manuscript received June 4, 1957)

OBSERVATIONS FROM SEVERAL experiments on quality retention in stored frozen peas at this Laboratory indicated that variation in maturity of peas could account for part of the variation in storage life of this product between different experimental packs. A careful test of this observation appeared of value, particularly in consideration of the work, previously published by the authors *(3)*, on the effect of storage temperature on quality of frozen peas. In that paper storage deterioration was described for frozen peas that were in the very low maturity range. Tenderometer readings for these peas ranged from 76 to 81, whereas commercial frozen packs would be expected to range from 80 to 110.

Using peas selected from lots obtained for a study of methods for measurement of maturity, reported by Makower, Boggs, Burr, and Olcott *(5)*, an investigation was undertaken to study rate of quality deterioration of frozen peas of three maturity levels representing the expected commercial range.

PROCEDURES

As described by Makower *et al. (5)*, Thomas Laxton peas were grown under the direction of the Utah Agricultural Experiment Station at Farmington, Utah, in 1949 and 1950, harvested at intervals over a range of tenderometer values of 84 to 107, iced in the pod, transported by air express to Albany, California, stored overnight at 34° F., and processed the following day. At no time were peas held more than 24 hours after harvest and maximum temperature of the peas was 62° F. Boggs and Talburt *(1)* have shown that little or no flavor deterioration occurs during holding of peas in the pod under these conditions. After mechanical hulling, the peas were size graded, steam blanched 90 seconds at 212° F., fog cooled 2 minutes, and frozen at −10° F.

To simulate the size distribution characteristic of most commercial frozen pea packs, peas of sieve size 3–6 inclusive (11/32–14/32 inches in diameter) were used except as indicated later. These were prepared by combining 2 size-group lots from each harvest that had been separated as required by the maturity study of Makower *et al. (5)*. These were sizes 3 and 4 and sizes 5 and 6, mixed in the proportions present in the original field-run material.

In addition, the second season's investigation included a comparison of small peas, sizes 3 and 4, with larger peas, sizes 5 and 6, at two harvest maturity dates.

All samples were hermetically sealed in No. 2 cans (307 x 409), plain tin, and held at −10° F. for intervals up to 8 weeks prior to controlled storage tests. Thereafter, all samples were held at −30° F. for control purposes.

Reduced ascorbic acid was determined by the method of Loeffler and Ponting *(4)* as modified by Ponting *(6)*. Total solids and alcohol-insoluble solids were determined by the method described by Lindquist *et al. (3)*.

Color, off-flavor, and skin texture judgments were made by scoring 4 times by a trained, selected panel of 11 to 13 judges. Score 7 indicated bright green color, no off-flavor, and very tender skins; score 1 indicated grey or yellow-green color, much off-flavor, and very tough skins. Flavor and texture were evaluated under a sodium vapor light to mask color differences. Color was judged under artificial lights to simulate daylight conditions. Samples used in judging each factor were independently coded and randomized.

Sample preparation for evaluation consisted of placing 300 g. of frozen peas in 150 ml. of boiling water and cooking in an uncovered beaker for 5 minutes after resumption of boiling. Drained, unseasoned, whole peas were evaluated except in the experiment in which peas of different sizes were compared. For this exception, to avoid sample identification by size difference, the cooked peas were blended in a kitchen blender after replenishing water lost in cooking.

Storage procedure for 1949. Of the 4 available harvests, 3 maturities of Thomas Laxton peas were selected with tenderometer readings of 84, 98, and 104. Samples were distributed at −30°, −10°, 0°, and 10° F. so as to enable comparison of quality changes after equal time intervals at these temperatures.

Since each maturity lot required a week for the replicated appraisals, the lots were placed in storage a week apart. Thus, each lot was appraised within a week after each storage trial at −10°, 0°, and 10° F. was completed. Experimental samples were held at −30° F. during intervals of delay pending evaluation of quality.

Storage procedure for 1950. Three lots of peas were selected with tenderometer readings of 85, 90, and 107. A modification of experimental design, using −30° F. storage as a condition of negligible change, allowed storage at elevated temperatures for various time intervals terminating on a given date. Thus, the effect of comparing quality change for several time intervals at a given temperature was achieved. Dates of transfer from a holding temperature of −30° F. to higher temperatures of −10°, 0°, and 10° F. were arranged to have all time intervals for one temperature end on the same day. By this procedure, prolonged holding of samples at −30° F. for analysis and appraisal was avoided after storage at higher temperature.

Storage time at −30° F. was considered to have a negligible effect in view of the data of Ward and Boggs *(8)* which report no significant flavor difference between frozen peas stored 14 months at −30° and −60° F., nor between peas stored 14 months at −30° F. and unstored peas from the same source the next harvest.

Also, as a check against seasonal variation, a replication of the 1949 procedure was made to compare samples stored at several temperatures against each other at given time intervals.

DISCUSSION OF EXPERIMENTAL DATA

Analytical data are in general agreement with those presented by Lindquist *et al. (3)* on less mature peas (See Table 1, page 5, reference *3*).

The only significant changes in chemical composition noted in the 1949 pack of peas during storage were losses in ascorbic acid (ASA) content. The percentage retention decreased as the storage temperature was increased, with losses up to 43% being observed in peas stored at 10° F. for 40 weeks. There is some indication that the rate of loss is greater in the less mature samples.

Ascorbic acid data for 1950, Table 1, show only

[a] Western Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

TABLE 1

Effect of maturity on reduced ascorbic acid retention in frozen Thomas Laxton peas during storage

1949 Season				1950 Season			
	Maturity				Maturity		
	Low	Medium	High		Low	Medium	High
Tenderometer reading [1]	84	98	104		85	90	107
Total solids — % [2]	20.3	21.8	22.6		—	—	—
Alc.—insol.—solids — %	11.0	12.9	14.4		—	—	—
Ascorbic acid — mg. %	26.1	25.8	24.7		26.6	27.1	23.8
Storage Conditions	% Retention of ASA			Storage Conditions	% Retention of ASA		
7 wk. at 10°F	87	88	100	8 wk. at 10°F	85	87	92
13 wk. at 10°F	80	81	91	17 wk. at 10°F	73	72	85
25 wk. at 10°F	69	73	80	26 wk. at 10°F	67	65	77
40 wk. at 10°F	57	—	68	34 wk. at 10°F	59	60	74
7 wk. at 0°F	93	97	97	9 wk. at 0°F	93	95	98
13 wk. at 0°F	91	90	91	30 wk. of 0°F	81	83	91
25 wk. at 0°F	84	85	92	45 wk. at 0°F	80	77	89
40 wk. at 0°F	70	74	84	60 wk. at 0°F	75	73	85
7 wk. at −10°F	100	95	94	17 wk. at −10°F	97	97	100
13 wk. at −10°F	100	90	97	35 wk. at −10°F	95	98	102
25 wk. at −10°F	97	92	97	52 wk. at −10°F	98	98	102
40 wk. at −10°F	87	86	89	69 wk. at −10°F	96	92	100
				41 wk. at 10°F	49	44	62
				41 wk. at 0°F	85	85	92
				41 wk. at −10°F	93	95	93

[1] Fresh, field-run peas.
[2] Analysis run on frozen controls held at −10° or −30°F.

small changes at −10° F., whereas values at 0° and 10° F. showed less retention with longer storage and higher temperatures. Losses ranged from 15 to 27% in 60 weeks at 0° F. and 26 to 41% in 34 weeks at 10° F. The more mature peas showed the least percentage loss; however, the final content was about the same as in the less mature samples. These losses in reduced ascorbic acid parallel the development of off-flavor with time.

A Hunter reflectometer was used to measure reflected color as described by Eastmond *et al. (2)*. Reproducibility of reflectance color measurements on whole cooked peas was such that it was difficult to show consistent small changes in the maturity lots for two seasons. Data indicate the same general trends in color change as observed in the previous storage studies on peas *(2)*; namely, the peas stored at higher temperatures became slightly darker, yellower, and grayer.

Average value of each judge's replicate scores from the organoleptic evaluations was treated statistically by analysis of variance. Each stored sample was compared with control material of the same maturity which had been stored at −10° F. or −30° F. Sources of variation in these analyses were main effect of treatments and judges, and the remainder. Thus, variance of remainder was a measure of variability of order of scores. The Scheffé least significance value *(7)*[6] was calculated when the F ratio was significant (See Table 2).

$$\text{L.S.D. at 5\%} = \sqrt{\frac{\text{Mean square (remainder)} \times 2 \times \text{Degrees of Freedom (treatment)} \times \text{F ratio at 5\%}}{\text{No. of judgments per treatment}}}$$

$$\text{F ratio is } \frac{\text{Mean square for treatment}}{\text{Mean square for error}}$$

Results in Table 2, for the 3 maturity lots for each pair of temperature conditions evaluated, indicate that the least mature peas tend to develop off-flavor sooner than the two more mature lots handled under identical conditions. Only two of the lots stored at different temperatures showed differences between the medium and most mature lots. In these two instances, the medium mature peas developed off-flavor sooner than the most mature peas. Longer storage intervals might have caused more differences to develop between the medium and most mature lots.

Color and skin texture data show the same trends as flavor but at a slower rate; therefore, they were not tabulated.

Although the main purpose of this investigation was concerned with the relative stability of peas of varying maturity, the intervals when off-flavor was first noted at various storage temperatures are of interest too. These times are summarized below, together with similar findings from an earlier publication of the authors *(3)*. The peas used in the earlier investigation were Ferry Morse No. 9, a Laxton Progress type, of maturity similar to the least mature peas of the present report. The 5% level of significance is the criterion used in the following discussion. Peas stored at −10°, 0° or 10° F. were compared with control peas stored at −10° F. or −30° F.

At 10° F. the storage intervals when off-flavor was was first noted for least mature peas was 6 and 17 weeks for 1949 and 1950, respectively (8 weeks in the earlier publication). For medium mature peas, the time was 24 and 34 weeks; and for most mature peas, 24 weeks in 1949. In 1950, the most mature peas had not developed off-flavor after 34 weeks in one trial and 41 weeks in another trial, which were the longest intervals investigated.

TABLE 2

Effect of maturity on off-flavor development in frozen Thomas Laxton peas during storage

Harvest year	Tenderometer reading	Storage temp.	Storage periods tested, weeks	Storage periods with significant off-flavor	
				P = 0.05 weeks	P = 0.001 weeks
1949	84	10°F	0, 6, 13, 24	6, 13, 24	13, 24
	98	10°F	0, 6, 13, 24	24	None
	104	10°F	0, 6, 13, 24	24	None
1950	85	10°F	0, 8, 17, 26, 34, 41	17, 26, 34, 41	34, 41
	90	10°F	0, 8, 17, 26, 34, 41	34, 41	41
	107	10°F	0, 8, 17, 26, 34, 41	None	None
1949	84	0°F	0, 3, 6, 13, 24, 38	38	38
	98	0°F	0, 3, 6, 13, 24, 38	None	None
	104	0°F	0, 3, 6, 13, 24, 38	None	None
1950	85	0°F	0, 9, 30, 45, 60	60	60
	90	0°F	0, 9, 30, 45, 60	60	None
	107	0°F	0, 9, 30, 45, 60	60	None
1949	84	−10°F	0, 51	51	None
	98	−10°F	0, 51	None	None
	104	−10°F	0, 51	None	None
1950	85	−10°F	0, 7, 34, 41, 52, 68	None	None
	90	−10°F	0, 7, 34, 41, 52, 68	None	None
	107	−10°F	0, 7, 34, 41, 52, 68	None	None

At 0° F. the storage intervals when off-flavor was first noted for least mature peas, were 38 and 60 weeks in 1949 and 1950, respectively (in the earlier report, 32 weeks was the first interval for which the trend held steady, although significance was found in a few shorter periods). In 1949, neither of the two more mature lots showed deterioration after 38 weeks, which was the longest period tested. In 1950, both showed deterioration after 60 weeks, but neither sample had developed off-flavor in 45 weeks.

In order to approach the maturity and temperature-storage relationship in another way, a series of investigations was carried out in 1950 in which the pea size was the index of maturity. Peas of sizes 3 and 4 mixed together were compared for quality changes with sizes 5 and 6 mixed together, all from one harvest lot. (Contrasting with the other data discussed above representing samples harvested from one field on different days and where the varying tenderometer readings were the indices of maturity.)

Results for comparison of the two size groups are summarized in Table 3. The data show that smaller peas developed more off-flavor than the larger peas under the storage conditions investigated. Two maturity lots for each size group were stored 21 weeks at 10° F., and stored 30 and 55 weeks at −10° F. The first lot had 54% sizes 3 + 4 and the second lot had 40% sizes 3 + 4, figured on the basis of combined weight of sizes 3 to 6 inclusive. The magnitude of the score differences was very striking.

TABLE 3

Influence of maturity on off-flavor development during storage of frozen Thomas Laxton peas[1] at 10° and −10° F. (pea size used as index of maturity)

Storage temperature °F.	Storage Period weeks	Field-run tenderometer reading	Off-flavor scored[4]		Least significant difference	
			Sizes 3+4	Sizes 5+6	P = 0.05	P = 0.001
10	21	85[2]	3.2	5.8	0.6	1.1
		90[3]	3.4	5.5	0.8	1.7
−10	30	85	4.2	5.5	0.5	1.0
		90	4.6	5.6	0.8	1.6
−10	55	85	4.0	6.0	0.7	1.4
		90	4.1	6.0	0.6	1.2

[1]Maturity 1 and 2, 1950 season.
[2]Tenderometer reading of sizes 3+4 was 77 and sizes 5+6 was 92.
[3]Tenderometer reading of sizes 3+4 was 80 and sizes 5+6 was 91.
[4]Lower scores indicate more off-flavor.

Differences in color between the two size groups of each comparison were always smaller than differences for off-flavor. These differences were significant for both lots stored at 10° F., but storage at −10° F. did not produce a difference. These comparisons indicate that fancy packs are more susceptible to deterioration than more mature packs and require lower temperatures or shorter holding times to maintain quality.

SUMMARY

Storage stability studies are reported for Thomas Laxton peas at three maturity levels for two harvest seasons. Samples were stored at −30°, −10°, 0° and 10° F. for several time intervals from 0 to 69 weeks. Changes in ascorbic acid and flavor and color scores were observed. Small and immature peas were found to be more susceptible to deterioration than the large and more mature peas.

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Effects of Jar Size, Liquor, and Product-to-Liquor Ratio on Heating Characteristics of Fresh-Packed Pickle Products[a, b]

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(Manuscript received May 15, 1957)

DETERMINATION OF THE CORRECT PROCESS for fresh cucumber pickle pasteurization has two distinct aspects; first, a determination of the amount of heat necessary to inactivate the spoilage agent, and, second, a solution of the physical problem of delivering that heat. Considerable work has been done to determine the amount of heat required for pasteurization *(2, 3)*; however, the physical aspect of the problem has not been examined in detail. This paper describes some of the physical factors that influence the rate and amount of heat received by the fresh packs. The data of this study will aid the pickle packer in the evaluation of these factors so that he may scientifically adjust his process to different packs.

EXPERIMENTAL

Two cucumber shapes, 2 liquors, 6 jar geometries, and 4 pickle-to-liquor ratios were studied. The 2 cucumber shapes used were slices cut 7/32 in. thick from No. 3 variety SR-6 pickling cucumber, and spears made by slicing the No. 3 cucumbers lengthwise into 5 equal wedges. Brine containing 14-grain (1.4%) acetic acid and 5.0% salt and a syrup containing 50% sucrose were used as covering liquors. Jar data are given in Table 1. Spear weights of 10.00, 11.25, 12.00, and 13.50 oz. in 16-oz. jars were studied.

TABLE 1
Jar dimensions

Name	Normal fill (oz.)[1]	Outside dia. (in.)	Height to top of finish (in.)	Jar weight (gm.)
Vegetable	16	3	4 3/8	202
Cylinder	16	2 7/8	5 1/2	259
Cylinder	22	3	7 1/4	366
Novelty	24	3 3/4 [2]	7 1/8	385
Icebox	28	4	5	346
Regular	32	3 3/4	7 1/4	370

[1] Overflow capacity is about 1/2 oz. more.
[2] Largest diameter.

The cucumber products were weighed into the jars to the nearest 0.25 oz. and the liquor at 135 ± 10° F. was added just prior to placing the jars in the water bath.

Temperatures in the jars were sensed with pencil-type copper-constantan thermocouples similar to those described in *(5)* and were measured with a 12-point recording potentiometer. Thermocouples were located in the neighborhood of the slowest heating point along the central axes of the jars at 0.2h from the jar bottom, where h is the liquid height. Jars were heated in a constant temperature water bath in which the point-to-point variation in the region where the jars were placed was less than 1¼° F., and in which the temperature at any particular point varied about its mean with a standard deviation of ¼° F.

ANALYSIS

Time-temperature plots of the experimental data were made according to Ball *(1)*, and the heating rate, f_h, and lag factor, j, were determined. Sterilizing values were computed at the end of various times using the fundamental equation defined by Ball *(1)*, in which are implicit the assumptions that heating rate is proportional to temperature difference, and that the destruction rate of the system critical in proper pickle pasteurization is logarithmic with an F_{180} of 36 minutes and a z of 18° F. *(2)*. Values of the F-integral were obtained from the Jahnke-Emde tables *(4)*. Significant differences, where investigated, were obtained from an analysis of variance of the data; any significant differences listed below are at the 5% level.

DISCUSSION AND RESULTS

Jar geomtery. The effect of jar geometry on heating characteristics of slices in both brine and syrup was studied for the 6 jar types. Table 2 gives the mean values of the heating characteristics. The 22-oz. and 24-oz. jars, although of larger capacity than the 16-oz. jars, do not have a correspondingly larger j or f_h. The 28-oz. jars with syrup have a much larger f_h than the 32-oz. jars. These facts reflect the more favorable geometry of the 22-oz. and 24-oz. jars; namely, a larger surface-to-volume ratio and a smaller diameter. By contrast, the 28-oz. jars have a low surface-to-volume ratio.

Liquor. Results of the studies of cucumber slices are summarized in Table 2. The lag factor, j, was not significantly different between liquors in all jar types studied. The f_h values for jars containing syrup were significantly higher than the f_h values for jars containing brine. The increase was not the same for each jar type. In brine packs, the f_h of the 22-oz., 24-oz., 28-oz., and 32-oz. jars is significantly higher than the f_h of the 16-oz. jars. In syrup packs, the 28-oz. and 32-oz. jars have significantly higher f_h values than the other four jar types. These data indicate the existence of a jar-liquor interaction, because the order of increasing f_h among jars changes with a change in liquor. The following comparisons refer to brine and syrup. When brine packs were compared with syrup packs, the syrup packs showed an increase in the f_h of about 60% in the case of the

[a] Journal Paper No. 2079 Michigan Agricultural Experiment Station, East Lansing, Mich.

[b] Presented before the Seventeenth Annual Meeting of the Institute of Food Technologists, Pittsburgh, Pa., May 15, 1957.

TABLE 2

Jar geometry: mean values of heating characteristics of slices

Jar	Brine				Syrup			
	No. of runs	j	f_h	F_{160} at 25 min.	No. of runs	j	f_h	F_{160} at 25 min.
16 oz. VEG	4	1.32	19.2	32.9	6	1.45	31.4	4.6
16 oz. CYL	4	1.34	19.6	30.5	6	1.42	32.7	3.4
22 oz. CYL	4	1.36	23.3	19.1	6	1.24	34.5	3.4
24 oz. NOV	4	1.37	21.9	19.4	6	1.31	34.8	3.6
28 oz. ICE	4	1.23	21.2	29.8	6	1.32	50.8	0.4
32 oz. REG	4	1.24	23.5	18.1	6	1.37	44.8	0.8

16-oz., 22-oz., and 24-oz. jars, and an increase of about 100% in the case of the 28-oz. and 32-oz. jars. The sterilizing value at 25 minutes was reduced to about 14% and 3% respectively for these two groups of jars.

Cucumber spears are normally packed in 16-oz. vegetable and 28-oz. jars; therefore, this study was restricted to these 2 sizes. Results are summarized in Table 3. The lag factor, j, was significantly increased by about 40% and the heating rate, f_h, was increased by 100% in both cases.

Pickle-to-liquor ratio. The effect of increased pickle-to-liquor ratio was studied in spear products in syrup in 16-oz. vegetable jars and the results are given in Figure 1. The points circled represent the individual data and the vertical lines indicate the mean values. An analysis of variance of the data from these 34 jars showed no significant difference in the lag factor, j, and a significant difference in the sterilizing value, F_{160}. The change in f_h was not statistically different; however, there may be a real decrease in f_h with increased ratio that is masked by the large variation among jars for a given ratio. The increased pickle-to-liquor ratio resulted in an increased lag factor. The 10-oz. and 11¼-oz. packs were not different, but all other comparisons were statistically different. The increased ratio resulted in a decreased sterilizing value. The 10-oz. pack was different from the 12-oz. and 13½-oz. packs; the 11¼-oz. pack was different from the 13½-oz. pack. Results indicate that under these conditions the lag factor, j, and not the f_h value is responsible for the decrease in the sterilizing value of pickle spears in syrup.

A large coefficient of variation was associated with the f_h, and j values in all tests where pickle products were involved. These values were consistently of the order of magnitude of 10%; whereas, when brine or syrup alone was used, the coefficient of variation was 3%. The f_h and j values with a coefficient of variation of 10% produce a corresponding variation in sterilizing value, F_{160}, of about 50%.

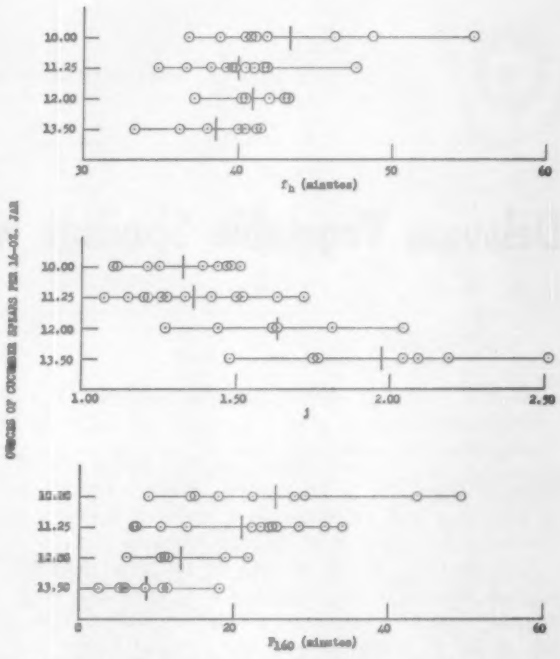

Figure 1. Effect of pickle-to-liquor ratio on heating characteristics.

SUMMARY

The heating rate, lag factor, and sterilizing value have been determined for controlled packs of cucumber slices and spears in jars with different geometries and with different liquors. Effects of jar size and liquor on the different packs are presented in tabular form. In general, a product in syrup heats more slowly than the same product packed in brine. Increasing the product-to-liquor ratio, while it does not significantly change the rate at which the jar heats, does increase the lag factor; the net result is a decrease in the sterilizing value.

TABLE 3

Mean values of heating characteristics of spears

Jars	Brine				Syrup			
	No. of runs	j	f_h	F_{160} at 25 min.	No. of runs	j	f_h	F_{160} at 30 min.
16 oz. VEG	21	1.21	21.0	32.5	12	1.52	40.8	3.2
28 oz. ICE	12	1.17	24.7	20.4	12	1.67	51.6	0.6

Acknowledgments

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Delaying Vegetable Spoilage with Antibiotics[a]

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Bacterial decay causes serious losses in vegetables after harvest. Modern techniques in handling and shipping have reduced losses substantially but the cost of spoilage remains high.

The need for better control of bacterial rots has created interest in the possible use of antibiotic treatments.[b] Smith *(5)* reported a 2-day extension of shelf life at 70° F. when spinach was sprayed before harvest or dipped after harvest in antibiotic solutions. Streptomycin and oxytetracycline were equally effective at 1000 p.p.m.; chlortetracycline was slightly less effective. Brody and Francis *(1)* reported a 40% reduction of bacterial soft rot in spinach by a one-minute dip treatment in a 500-p.p.m. solution of streptomycin sulfate. Koch and Carroll *(4)* reported reduction in decay with oxytetracycline, streptomycin, polymyxin and neomycin dip treatments of spinach. Cox *(2)* reported effectiveness of combinations of oxytetracycline and streptomycin as post harvest treatments for prevention of soft rot of lettuce. Cox and coworkers *(3)* recently reported complete control of radish pit after 5 days' storage at temperatures of 5° to 35° C. after 5-minute dip treatments of 40-p.p.m. oxytetracycline solutions. Streptomycin at the same concentration was not as effective and did not give control at 35° C.

[a] Presented at the Seventeenth Annual Meeting of the Institute of Food Technologists, Pittsburgh, Pennsylvania, May 15, 1957.

[b] A tolerance under the Miller Amendment to the Federal Food, Drug, and Cosmetic Act has not been established for oxytetracycline, streptomycin, or polymyxin in or on salad mixes.

EXPERIMENTAL

In this study the effects of oxytetracyline hydrochloride, streptomycin sulfate, and polymyxin B sulfate as dip treatments on a salad mix and on each of the salad components were examined. Effects were observed at different temperatures. Rate of decay was measured by careful visual inspection, by recording the amount of fluid exuded from each sample, by bacterial counts of the exudate, and by odor.

Vegetables used were cucumber, chicory, escarole, iceberg lettuce, radish and red cabbage. All vegetables were obtained through wholesale channels in New York City; harvest dates were not available. Bruised, discolored, or infected material was removed before the vegetables were cut and washed in water. The salad mix and the individual samples were each immersed in the antibiotic solutions for 30 seconds and drained to remove excess liquid. Two hundred-gram samples in triplicate were packed in unsealed polyethylene bags. The salad mix was treated with 25-p.p.m. and 50-p.p.m. solutions of each of the 3 antibiotics and samples were stored at 5° C., 10° C., and 30° C. Individual vegetables were treated at 50 p.p.m. and stored at 30° C.

Percentage of rot was estimated by visual inspection. Discolored and water-soaked areas were separated from healthy tissue. An appreciable degree of decay occurred in all control samples facilitating comparison with treated samples. The exudate in each sample was drained and measured before rating percent decay. Each sample was also rated for decay odor.

TABLE 1

Decay in salad mix stored at 30° C. for 24 hours

Sample No.	Treatment Level [1]	Estimated Visual Decay	Exudate Volume	Odor
		%	cc.	
1	Oxytetracycline·HCl, 50 p.p.m.	0—5	<1	None
2	Oxytetracycline·HCl, 25 p.p.m.	0—5	<1	None
3	Streptomycin sulfate, 50 p.p.m.	15	5	Strong
4	Streptomycin sulfate, 25 p.p.m.	20	8	Strong
5	Polymyxin B sulfate, 50 p.p.m.	30	13	Strong
6	Polymyxin B sulfate, 25 p.p.m.	35	16	Strong
7	Control	50	44	Rotten

[1] Samples were dipped for 30 seconds in water solutions of the antibiotics; the control also was dipped in water for 30 seconds.

TABLE 2

Decay in salad mix stored at 30° C. for 48 hours

Sample No.	Treatment Level [1]	Estimated Visual Decay	Exudate Volume	Odor
		%	cc.	
1	Oxytetracycline·HCl, 50 p.p.m.	5—10	3	Very Slight
2	Oxytetracycline·HCl, 25 p.p.m.	15	10	Slight
3	Streptomycin sulfate, 50 p.p.m.	25	25	Rotten
4	Streptomycin sulfate, 25 p.p.m.	35	40	Rotten
5	Polymyxin B sulfate, 50 p.p.m.	40	50	Rotten
6	Polymyxin B sulfate, 25 p.p.m.	50	60	Rotten
7	Control	70	80	Rotten

[1] Samples were dipped for 30 seconds in water solutions of the antibiotics; the control also was dipped in water for 30 seconds.

Viable bacterial counts in triplicate were made on the liquid exudates. Trypticase Soy Seed Agar (Baltimore Biological Laboratory, Baltimore, Maryland) was used as the culture medium and plates were stored at 30° C. for 24 hours. The exudate was used in the determinations because the salad mix was not a homogeneous material for sampling.

RESULTS

Effects of the antibiotic treatments on the salad mix held at 30° C. for 24 hours are presented in Table 1. Only the oxytetracycline prevented decay development. Streptomycin at 50 p.p.m. reduced decay development substantially. Strong to rotten odors were detected in all other samples. Increasing volumes of exudates were found in the streptomycin, polymyxin, and control.

Table 2 presents results with the same samples after storage for 48 hours at 30° C. Percent decay, volume of exudate, and odor were markedly increased in most samples. Oxytetracycline at 50 p.p.m. rated well above all other treatments.

Table 3 presents bacterial counts on exudates from the control sample and from samples treated with 50 p.p.m. of each antibiotic after 24 hours. The bacterial count for streptomycin was approximately ten times greater than for oxytetracycline; the difference was slightly higher when oxytetracycline is compared with polymyxin. The high count in the control exudate shows the rapidity of bacterial population increase when untreated samples are held at 30° C.

TABLE 3

Bacterial count of exudates from salad mix stored at 30° C. for 24 hours

Treatment	Exudate Volume	Viable Bacteria
	cc.	cc.
Oxytetracycline·HCl, 50 p.p.m.	<1	26,000,000
Streptomycin sulfate, 50 p.p.m.	5	260,000,000
Polymyxin B sulfate, 50 p.p.m.	13	320,000,000
Control	44	6,000,000,000

In Table 4 data show the effect of antibiotic treatments on cucumber, chicory, escarole, and iceberg lettuce stored at 30° C. for 24 hours. None of the radish or red cabbage samples showed signs of visual decay. Oxytetracycline was the most effective antibiotic and streptomycin was the second most effective treatment. At 48 hours (Table 5) increased decay was evident in all samples. Only oxytetracycline prevented rapid deterioration of cucumber. Results obtained in these tests indicate that cucumber and chicory were most susceptible to rot development. Their presence probably accelerates decay in the other components of the salad mix.

In Table 6 data show the effect of antibiotic treatments on the salad mix stored at 10° C. for 7 days. Both levels of oxytetracycline inhibited decay development in the mix; only traces of initial symptoms of decay were detected in the lettuce component. Both levels of streptomycin treatment were less effective as there were some water-soaked areas on the leafy vegetables. Greater decay was observed in those treated with polymyxin and control.

The amount of decay after 12 days at 10° C. is presented in Table 7. Samples treated with oxytetracycline at 50 p.p.m. showed the least amount of spoilage. Streptomycin at both levels used also reduced decay while polymyxin treatments were no better than the control.

TABLE 4

Decay in vegetables stored at 30° C. for 24 hours

Vegetable	Treatment Level [1]	Estimated Visual Decay	Exudate Volume	Odor
		%	cc	
Cucumber	Oxytetracycline•HCl, 50 p.p.m.	0—2.5	<1	None
	Streptomycin sulfate, 50 p.p.m.	5—10	8	Moderate
	Polymyxin B sulfate, 50 p.p.m.	5—10	5	Moderate
	Control	50	51	Very Strong
Chicory	Oxytetracycline•HCl, 50 p.p.m.	None	<1	None
	Streptomycin sulfate, 50 p.p.m.	0—5	<1	None
	Polymyxin B sulfate, 50 p.p.m.	5—10	2	Moderate
	Control	15	6	Strong
Escarole	Oxytetracycline•HCl, 50 p.p.m.	0—5	<1	None
	Streptomycin sulfate, 50 p.p.m.	5	<1	Slight
	Polymyxin B sulfate, 50 p.p.m.	10	<1	Moderate
	Control	15	<1	Strong
Lettuce	Oxytetracycline•HCl, 50 p.p.m.	None	<1	None
	Streptomycin sulfate, 50 p.p.m.	5	<1	Trace
	Polymyxin B sulfate, 50 p.p.m.	15	<1	Slight
	Control	15	<1	Slight

[1] Samples were dipped for 30 seconds in water solutions of the antibiotics; the control was also dipped in water for 30 seconds.

TABLE 5

Decay in vegetables stored at 30° C. for 48 hours

Vegetable	Treatment Level [1]	Estimated Visual Decay	Exudate Volume	Odor
		%	cc	
Cucumber	Oxytetracycline•HCl, 50 p.p.m.	15	2	Moderate
	Streptomycin sulfate, 50 p.p.m.	40	28	Strong
	Polymyxin B sulfate, 50 p.p.m.	70	65	Strong
	Control	90—100	100	Very Strong
Chicory	Oxytetracycline•HCl, 50 p.p.m.	10	7	Trace
	Streptomycin sulfate, 50 p.p.m.	20	20	Moderate
	Polymyxin B sulfate, 50 p.p.m.	35	50	Moderate
	Control	25	25	Rotten
Escarole	Oxytetracycline•HCl, 50 p.p.m.	0—5	<1	Moderate
	Streptomycin sulfate, 50 p.p.m.	15	25	Strong
	Polymyxin B sulfate, 50 p.p.m.	15	28	Strong
	Control	60	90	Rotten
Lettuce	Oxytetracycline•HCl, 50 p.p.m.	0—5	<1	None
	Streptomycin sulfate, 50 p.p.m.	10	<1	Moderate
	Polymyxin B sulfate, 50 p.p.m.	40	20	Strong
	Control	50	30	Rotten

[1] Samples were dipped for 30 seconds in water solutions of the antibiotics; the control also was dipped in water for 30 seconds.

In Table 8, data show the effects of antibiotic treatments on the salad mix stored at 5° C. for 12 days. Both treatments with oxytetracycline gave almost complete protection from decay. Streptomycin at 50 p.p.m. was slightly less effective. All remaining treatments showed obvious areas of decay development.

DISCUSSION

Rate of bacterial spoilage was found to vary with individual vegetables. Radish and red cabbage were resistant to decay during the storage periods used. Spoilage appeared more rapidly in cucumber and chicory. The tendency of the salad mix to decay appears to depend on the components. Vegetables which deteriorate rapidly seem to establish the rate of decay for the other components in a salad mix. The rapidity of bacterial population increase and formation of exudate emphasize the extreme care required in handling salad vegetables.

Oxytetracycline was the only antibiotic which gave practically complete control of spoilage. Streptomycin reduced decay but was not as effective or consistent. Polymyxin showed little or no protective action.

Oxytetracycline at 50 p.p.m. delayed spoilage in the salad mix stored at 30° C. "Weeping" was first detected at approximately 48 hours, at which time control samples showed 80 cc. of exudate.

Results obtained with oxytetracycline on the salad mix were confirmed in the results of treatment of the individual vegetables. Effectiveness of oxytetracycline in delaying spoilage is probably related to its greater biological activity against bacteria causing soft rot. Bacterial counts of the exudates appear to substantiate this opinion.

Refrigeration alone inhibits bacterial development, as observed in the condition of the control samples of the salad mix held for 12 days (Tables 7 and 8). Samples stored at 5° C. had 15% decay as compared

TABLE 6

Decay in salad mix stored at 10° C. for 7 days

Sample No.	Treatment Level [1]	Estimated Visual Decay	Exudate Volume	Odor
		%	cc.	
1	Oxytetracycline·HCl, 50 p.p.m.	0—2.5	<1	None
2	Oxytetracycline·HCl, 25 p.p.m.	0—2.5	<1	None
3	Streptomycin sulfate, 50 p.p.m.	5	<1	Slight
4	Streptomycin sulfate, 25 p.p.m.	5	<1	Slight
5	Polymyxin B sulfate, 50 p.p.m.	5—10	7	Slight
6	Polymyxin B sulfate, 25 p.p.m.	5—10	6	Moderate
7	Control	10	10	Moderate

[1] Samples were dipped for 30 seconds in water solutions of the antibiotics; the control also was dipped in water for 30 seconds.

TABLE 7

Decay in salad mix stored at 10° C. for 12 days

Sample No.	Treatment Level [1]	Estimated Visual Decay	Exudate Volume	Odor
		%	cc.	
1	Oxytetracycline·HCl, 50 p.p.m.	5	5	Trace
2	Oxytetracycline·HCl, 25 p.p.m.	15	7	Trace
3	Streptomycin sulfate, 50 p.p.m.	25	11	Slight
4	Streptomycin sulfate, 25 p.p.m.	30	12	Moderate
5	Polymyxin B sulfate, 50 p.p.m.	40	32	Strong
6	Polymyxin B sulfate, 25 p.p.m.	35	28	Strong
7	Control	45	48	Rotten

[1] Samples were dipped for 30 seconds in water solutions of the antibiotics; the control also was dipped in water for 30 seconds.

TABLE 8

Decay in salad mix stored at 5° C. for 12 days

Sample No.	Treatment Level [1]	Estimated Visual Decay	Exudate Volume	Odor
		%	cc.	
1	Oxytetracycline·HCl, 50 p.p.m.	0—2.5	<1	None
2	Oxytetracycline·HCl, 25 p.p.m.	0—2.5	<1	Trace
3	Streptomycin sulfate, 50 p.p.m.	2.5—5.0	<1	Trace
4	Streptomycin sulfate, 25 p.p.m.	5—10	4	Slight
5	Polymyxin B sulfate, 50 p.p.m.	10—15	6	Moderate
6	Polymyxin B sulfate, 25 p.p.m.	10—15	7	Moderate
7	Control	15	9	Moderate

[1] Samples were dipped for 30 seconds in water solutions of the antibiotics; the control also was dipped in water for 30 seconds.

to those held at 10° C. with 45% decay. Those samples treated with both levels of oxytetracycline and stored at 5° C. and 10° C. demonstrate the effect of the antibiotic superimposed on that of refrigeration.

SUMMARY

Solutions of oxytetracycline hydrochloride, streptomycin sulfate and polymyxin B sulfate were tested for decay control in six vegetables. Only oxytetracycline gave good control of spoilage. Oxtetracycline controlled spoilage up to 48 hours at 30° C. Longer delay of decay development was obtained with oxytetracycline at 5° C. and 10° C. Streptomycin was the second most effective antibiotic treatment. Polymyxin was least effective. Rate of decay was measured by visual inspection, volume of exudate, bacterial counts of the exudate and odor.

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Effect of Glucose Removal on Storage Stability of Egg Yolk Solids

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ONE OF THE PROBLEMS in the use of egg yolk solids is their susceptibility to changes in color, flavor, and functional properties during storage. These changes usually influence adversely the quality of foods in which the yolk solids are incorporated. It is known that many of these changes arise from a Maillard-type reaction involving glucose naturally present in eggs. Enzyme treatment to remove glucose is now used routinely in preparing egg white solids *(3)* but is not as yet widely used in the processing of yolk solids. Therefore, it seemed of interest to study the storage stability of yolk solids stabilized by enzyme treatment, and compare these solids with similar ones prepared without enzyme treatment.

PROCEDURE

Yolk solids samples. Two lots of egg yolk solids were prepared from the same batch of liquid egg yolks. One lot was enzyme-treated to remove glucose, the other lot was dried without enzyme treatment. The enzyme treatment consisted of the addition of an enzyme preparation containing glucose oxidase plus catalase and hydrogen peroxide to the liquid yolk *(3)*. Catalase breaks down hydrogen peroxide to give water and free oxygen; glucose oxidase catalyzes the reaction of glucose with oxygen to give gluconic acid. In the present instance, the time required to render the yolk sugar-free was 2 hours and 20 minutes.

Both lots of egg yolks were pasteurized at 145°F. for 3 minutes using a plate-type unit, then spray dried in a Mojonnier Spray Drier using an inlet air temperature of 340°F. and an outlet temperature of 140°F. Packing temperature for the yolk solids was 90°F. Samples of the 2 lots were then held in cold storage (40°F.) until subdivided for the study reported herein. Some of the chemical and microbiological properties of the egg yolk solids are listed in Table 1.

Storage conditions. Each of the lots of egg yolk solids was divided in half, one part being held under refrigeration (40–50°F.) to serve as controls, the other part being further divided and stored at 95°F. or at 68°F. Samples held at 95°F. were tested after 7, 14, 25, and 90 days of storage, while those at 68°F. were checked after 3, 6, 9 and 12 months. This arrangement gave the following samples to be tested at the end of each storage interval: (a) enzyme-treated yolk solids stored under refrigeration (stabilized control); (b) untreated yolk solids stored under refrigeration (unstabilized control; (c) enzyme-treated yolk solids stored at 95° or at 68°F. (stabilized stored); (d) untreated yolk solids stored at 95° or at 68°F. (unstabilized stored).

Testing procedure. It was decided to evaluate the quality of the egg yolk solids in cake-type doughnuts, since this product is commonly used in commercial doughnut mixes. It is frequently necessary to store the yolk solids before use because of seasonal production. Two commercial-type doughnut mixes, less the egg yolk solids, were utilized. Formulas for the mixes and for the doughnut doughs, are given in Table 2. These differed only in the type of flour used, and therefore in the amount of water needed to make a dough of the desired consistency. The flour in mix No. 1 had a higher protein and lower ash content, and a higher mechanical mixing tolerance (Brabender units) than the flour in mix No. 2.

Both the mixes and the various lots of egg yolk solids were stored in sealed containers to prevent exposure to air and absorption of moisture. The mixes were stored at 0°F. until needed.

Preparation of doughnuts. A quantity of doughnut mix sufficient for one day's run was removed from storage the afternoon before, and held overnight in an incubator at 70° ± 2°F. In preparing the doughs, the egg yolk solids were blended with the mix by stirring at slow (No. 1) speed on an electric mixer equipped with a paddle and a 12-quart bowl. The resulting mixture was added to the appropriate amount of tap water, and mixed for 30 seconds at slow speed, then 90 seconds at medium (No. 2) speed. Temperature of the water was regulated with respect to the temperature of the mix and of the room, so that the final dough temperature would be between 76° and 78°F.

Doughnut dough was transferred to the dough can of a doughnut machine.[a] The fat temperature was regulated between 375° and 390°F., and the air pressure adjusted to yield as nearly as possible a finished doughnut weighing 28 g. Gradual increase in pressure was necessary during each frying run, to keep the doughnut weight constant as the amount of dough in the dough can decreased. The averages and ranges for the pressures required are listed in Table 2.

Fat used for frying the doughnuts was a hydrogenated vegetable shortening designed for the bakery trade. At the end of each cooking day, a free fatty acid analysis *(1)* was made on the cooking fat. Fresh fat was added as necessary to keep the proper level for frying, and to keep the free fatty acid content below 0.4%.

Collection of samples. Each batch of doughnut dough made

[a] Doughnut Corp. of America, quality control model.

TABLE 1

Properties of egg yolk solids

Treatment	Moisture, percent	Fat, percent	Color (NEPA)	pH	Microbial Counts			
					Total	Coli	Yeasts	Molds
Untreated, pasteurized 145°F, 3 minutes	4.1	57.4	2.15	6.6	6,600	<10	<10	<10
Enzyme-treated, pasteurized 145°F, 3 minutes	4.0	57.7	2.15	6.3	2,200	<10	<10	<10

TABLE 2

Formulas for doughnut mixes, and for doughnut doughs, and air pressure required to yield a 28-gram doughnut

Ingredients of doughnut mixes	Mix No. 1	Mix No. 2
	pounds	*pounds*
Flour—Midwestern wheat	73.3	
Western soft wheat		58.7
Western winter wheat		14.6
Sugar—corn	2.0	2.0
granulated	27.6	27.6
Fat	3.6	3.6
Spray dried non-fat milk	3.6	3.6
Acid	1.5	1.5
Soda	1.07	1.07
Salt	1.2	1.2
Full fat soya flour	2.4	2.4
Ingredients of doughnut doughs		
	grams	*grams*
Doughnut mix	2202	2202
Egg yolk solids	68	68
Water	836	879
Air pressure in dough can		
	pounds	*pounds*
Average	2.72-3.28	2.56-3.14
Range	2.25-4.13	2.0 -5.0

approximately 7½ dozen doughnuts. No samples were collected from the first three dozen, since the first part of each run represented a period of adjustment to get uniform doughnuts of the proper size. Test samples were collected from the fourth, fifth and sixth dozen. The remainder of the run was not sampled, as by that time the amount of dough remaining in the machine was too small to yield uniform results.

Test samples collected from the 4th, 5th, and 6th dozen doughnuts were distributed as follows: all odd numbered doughnuts were set aside for testing; even numbered doughnuts were weighed to check on the pressure regulation. Of the odd numbered doughnuts, the first and last were put aside for fat analysis in order to represent the extremes of the run. Remaining doughnuts were placed alternately in 2 groups to serve as duplicate samples for volume determination and for quality evaluation. One doughnut from each of these groups was selected for fat analysis to represent the central part of the run.

Analysis of samples

Specific volume. Specific volume was determined after the doughnuts had cooled for 45 minutes. The sample of 8 doughnuts was weighed, and the volume determined by rape seed displacement, using a volumeter. The volume was divided by weight to give specific volume.

Fat content. Two doughnuts were used for each determination of fat content. Doughnuts were ground, dried overnight (16 hours) at 40°C. under vacuum, and the dried sample reground. The vacuum oven was equipped with a device for admitting dry air at the rate of 4 bubbles per second. Fat content of the dried sample was determined by a slight modification of the Mojonnier method *(2)*. The changes involved use of a 3-g. instead of a 2-g. sample, and addition of 8 rather than 10 ml. of 95% ethyl alcohol after digestion.

Quality evaluation. Doughnuts were scored for symmetry

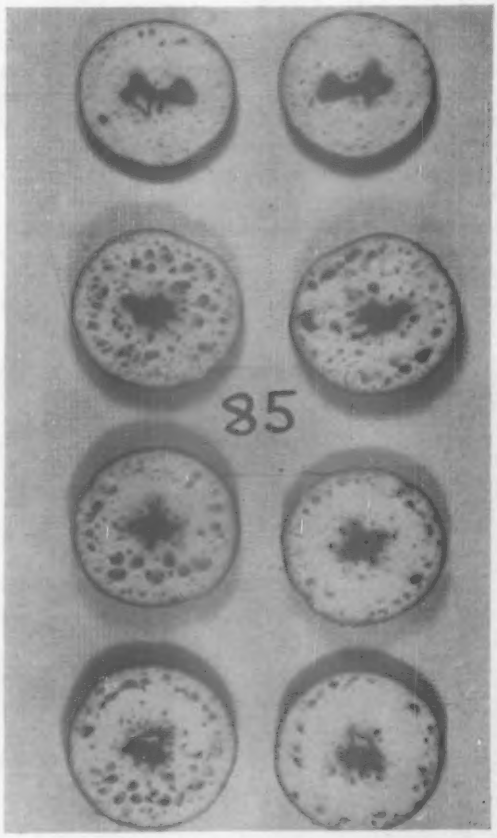

Figure 1. Interior texture of doughnuts containing 0, 3, 3 and 5% yolk solids (reading from the top).

TABLE 3

Data from doughnuts made with different amounts of egg yolk solids

Percent Egg Yolk Solids	Specific Volume	Percent Fat	Mix No. 1 [1] Scores [2]					
			symmetry	crust color	crust character	texture	flavor	inside color
0	2.57	21.48	5	6	6	5	5	5
1/2	2.80	23.17	6	6	7	6	6	6
1	2.91	26.97	7	7	7	7	6	7
3	3.27	30.77	9	8	8	9	8	8
1	2.99	31.55	6	6	6	5	5	6
3	3.25	33.67	9	9	9	8	8	8
5	3.47	32.50	8	9	8	9	9	9
7	3.62	31.94	8	9	7	8	8	9
	Mix No. 2 [3]							
0	2.74	17.24	6	6	7	5	6	5
1/2	2.88	18.45	6	6	7	6	6	5
1	2.96	19.09	7	7	7	7	6	6
3	3.23	21.70	9	8	9	8	7	7

[1] Average of 3 runs on different days.
[2] Scoring scale, 1 to 10.
[3] Average of 2 runs on different days.

(shape, and star formation at center hole), crust color (rich golden brown), crust character (smooth, not cracked or pitted), texture (internal—numerous large air cells), taste (mild and sweet), inside color (light creamy yellow), and odor (pleasant and sweet, not strong). A 10-point scale was used, with 10 being optimum. Since only one trained judge was available throughout the entire series, scores were considered as indicative, rather than decisive, in evaluating the results.

RESULTS AND DISCUSSION

Preliminary series. Several baking series were run to decide on the amount of egg yolk solids to add to the basic mix, and to gain experience in the operation of the doughnut machine and in judging quality. Stabilized egg yolk solids were used in these tests. The data obtained are summarized in Table 3.

Increasing the percentage of egg yolk solids from 0 to 3 increased specific volume and amount of fat in the finished doughnut, and improved the eating quality of the doughnuts. Further increase in the yolk solids increased the specific volume, but not the amount of fat, nor did the eating quality improve appreciably. Therefore, it was decided to use the 3% level for the evaluation of stored yolk solids.

Figure 1 shows the change in appearance of the doughnuts made with and without egg yolk solids. The doughnuts with no yolk solids were lighter in color both inside and out, had a mottled outer appearance, were more compact in texture and smaller than the doughnuts containing yolk solids.

Doughnuts made from the 2 mixes differed markedly in fat content, mix No. 1 showing a higher fat absorption capacity than mix No. 2, as would be expected from the differences in the flours. The 2 mixes also varied in the amount of water required in the dough (less in mix No. 1 than in mix No. 2) and in the amount of machine pressure required to produce a 28-g. doughnut (more variable for mix No. 2 than for mix No. 1). However, the pattern of change of specific volume, fat content, and eating quality with increase in amount of yolk solids was the same for both mixes.

Experimental series. Samples representing the 4

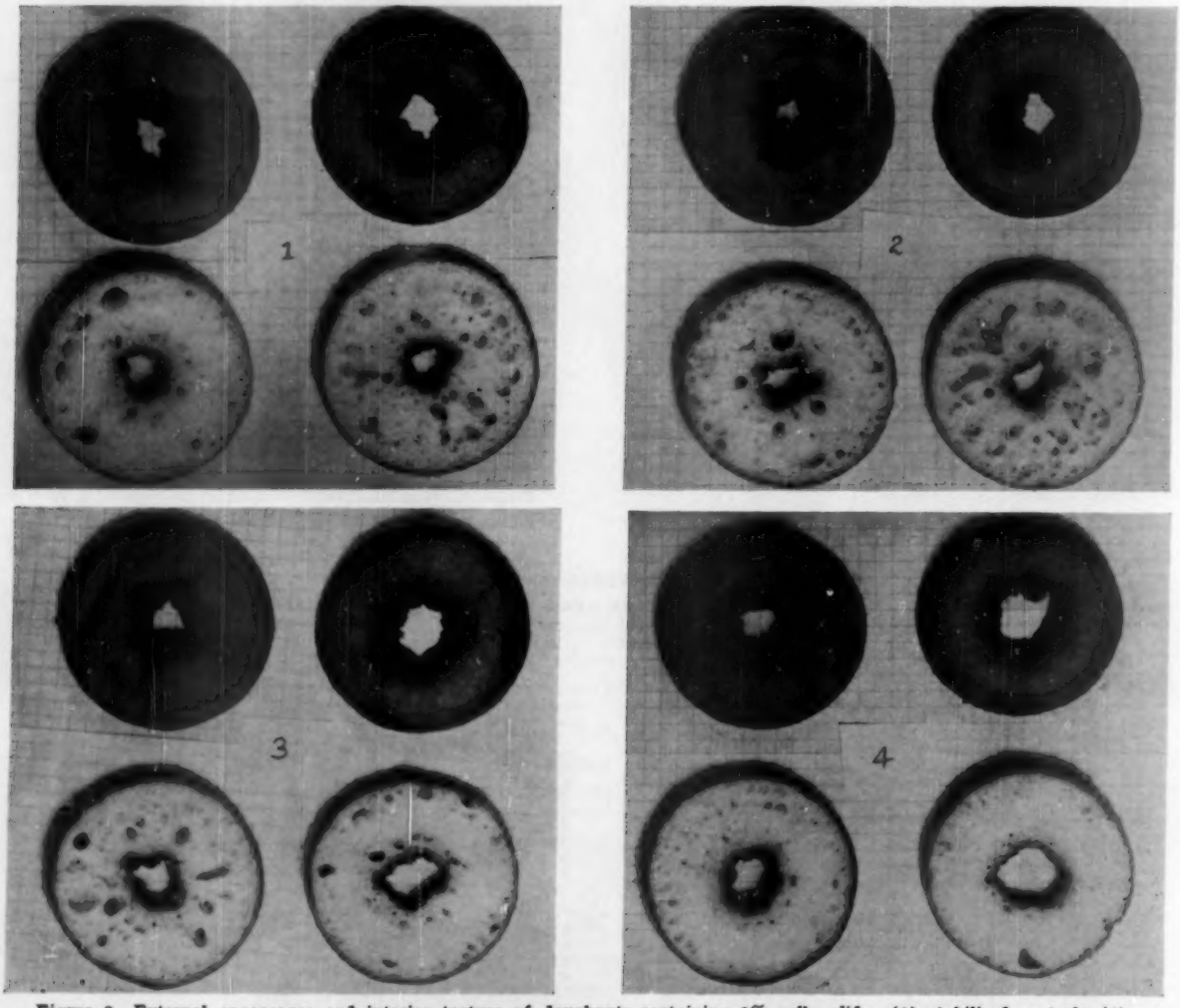

Figure 2. External appearance and interior texture of doughnuts containing 3% yolk solids: (1) stabilized control; (2) unstabilized control; (3) stabilized, stored 90 days at 95° F.; (4) unstabilized, stored 90 days at 95° F.

TABLE 4

Fat content of doughnuts, and mean squares from analysis of variance

Mix	Storage Temperature	Storage Time	% Fat in doughnuts [1]					Source of Variance	Mean Square
			Stabilized control	Unstabilized control	Stabilized stored	Unstabilized stored	Average		
No. 1	95°F. stored, refrigerated controls	7 days	31.30	32.17	33.69	33.38	32.61	Duplicate Samples	1.1362
		14	33.59	33.42	34.34	34.38	33.93	Treatment	94.1523**
		25	33.74	33.53	33.20	30.35	32.71	Storage	24.2255**
		40	34.35	32.73	32.59	27.54	31.80	Replication	0.676
		90	34.68	34.73	32.12	25.77	31.83	Remainder	6.9911
		Average	33.53	33.32	33.17	30.28			
	68°F. stored, refrigerated controls	3 mon.	33.60 [2]	30.96	31.00	30.94	31.63	Duplicate Samples	0.0397
		6	[3]	32.15	31.30	30.95	31.47	Treatment	17.3255**
		9	[3]	30.77	29.74	30.50	30.34	Storage	61.2603**
		12	34.77 [2]	33.18	35.10	32.99	34.01	Replication	0.390
								Part of Run	2.075
		Average	34.19	31.77	31.79	31.35		Remainder	2.1510
No. 2	95°F. stored, refrigerated controls	7 days	27.80	27.98	27.46	27.63	27.72	Duplicate Samples	0.0318
		14	28.35	27.70	28.31	26.75	27.78	Treatment	31.7683**
		25	27.62	26.71	28.21	25.45	27.00	Storage	12.7113**
		40	27.69	27.72	28.99	25.66	27.52	Replication	0.318
		90	27.02	26.37	27.19	24.49	26.27	Part of run	2.796
								Remainder	1.8717
		Average	27.70	27.30	28.03	26.00			
	68°F. stored, refrigerated controls	3 mon.	28.07 [2]	27.31	28.43	27.37	27.80	Duplicate Samples	0.0483
		6	[3]	28.79	29.86	29.73	29.45	Treatment	22.9253**
		9	[3]	27.18	29.81	28.53	28.51	Storage	41.7526**
		12	29.93 [2]	29.49	32.80	29.85	30.52	Replication	0.1291
								Part of run	1.5120
		Average	29.00	28.19	30.23	28.87		Remainder	2.0067

[1] Each figure represents the average of 8 values except as noted under [2].
[2] Only 4 values were available. All data based on dry weight of doughnuts.
[3] No yolk solids available.
* $p < 0.05$
** $p < 0.01$

TABLE 5

Specific volume of doughnuts, and mean squares from analysis of variance

Mix	Storage Temperature	Storage Time	Specific Volume [1]					Source of Variance	Mean Square
			Stabilized control	Unstabilized control	Stabilized stored	Unstabilized stored	Average		
No. 1	95°F. stored, refrigerated control	7 days	3.42	3.41	3.40	3.38	3.40	Duplicate Samples	0.0009
		14	3.38	3.38	3.35	3.39	3.38	Treatment	0.0122
		25	3.28	3.29	3.38	3.37	3.33	Storage	0.0952**
		40	3.24	3.26	3.26	3.14	3.22	Replication	0.0337*
		90	3.28	3.31	3.28	3.15	3.26	Remainder	0.00739
		Average	3.32	3.33	3.33	3.29			
	68°F. stored, refrigerated control	3 mon.	3.19 [2]	3.32	3.26	3.32	3.27	Duplicate Samples	0.00097
		6	[3]	3.26	3.28	3.28	3.27	Treatment	0.00363
		9	[3]	3.28	3.28	3.27	3.28	Storage	0.00297
		12	3.27 [2]	3.29	3.23	3.22	3.25	Replication	0.00370
								Remainder	0.00540
		Average	3.23	3.29	3.26	3.27			
No. 2	95°F. stored, refrigerated control	7 days	3.01	3.15	3.07	3.10	3.08	Duplicate Samples	0.00058
		14	3.08	3.00	3.10	3.06	3.06	Treatment	0.0191
		25	3.07	3.09	3.14	3.11	3.10	Storage	0.01155
		40	3.23	3.15	3.12	3.07	3.14	Replication	0.0120
		90	3.13	3.17	3.16	2.91	3.09	Remainder	0.01186
		Average	3.10	3.11	3.12	3.05			
	68°F. stored, refrigerated control	3 mon.	3.26 [2]	3.14	3.19	3.23	3.21	Duplicate Samples	0.0004
		6	[3]	3.16	3.11	3.14	3.14	Treatment	0.0045
		9	[3]	3.16	3.16	3.08	3.13	Storage	0.0229*
		12	3.09	3.15	3.11	3.04	3.10	Replication	0.0002
								Remainder	0.0060
		Average	3.18	3.15	3.14	3.12			

[1] Each figure represents the average of 4 values, except as noted under [2].
[2] Only 2 values were available.
[3] No yolk solids available.
* $p < 0.05$
** $p < 0.01$

treatments (stabilized control, unstabilized control, stabilized stored, and unstabilized stored) for each storage temperature and time were prepared on the same day. The series was repeated the next day as a replication. On any given day, the order of the 4 lots was randomized in order to eliminate any possible advantage due to time of day.

Data obtained on fat content and specific volume of the doughnuts are given in Tables 4 and 5, along with the mean squares from analysis of variance. Fat content of the finished doughnuts varied considerably. Since all mixtures had the same original fat content and since the data are calculated on the dry weight basis, these differences represent variations in the amount of fat absorbed during cooking. In general, the doughnuts containing enzyme-treated egg yolk solids had a higher fat absorption than those containing untreated yolk solids. Change in fat absorption was especially marked in the doughnuts made with untreated yolk solids stored at 95°F., the fat absorption tending to decrease with increasing storage. Doughnuts with lower fat content were more compact and therefore less palatable. When dried and ground, the low fat doughnuts gave a much finer product. These changes are illustrated in Figures 2 and 3.

Specific volumes did not seem to be affected appreciably by treatment of the egg yolks at the time of manufacture. Effects of storage were variable; with mix No. 1 the specific volume tended to decrease with increasing storage of the egg yolk solids at 95°F., but not in the set stored at 68°F. In mix No. 2 the specific volume decreased with egg yolk solids stored at 68°F., but not with solids stored at 95°F.

It was noted that at 25 days' storage at 95°F., untreated egg yolk solids were beginning to change color. Treated solids retained their bright lemon-yellow color, but the untreated ones became duller in color (described as a mustard-yellow) and developed a slightly different odor. These changes in the untreated solids became progressively more marked with longer storage.

As found in the preliminary work, there was considerable differences in results between the two mixes. Doughnuts made from mix No. 1 had considerably higher fat contents than those made from mix No. 2. Mix No. 1 also yielded doughnuts of higher specific volume than did mix No. 2.

SUMMARY

Egg yolk solids which had been enzyme-treated to remove glucose were compared with untreated solids in respect to storage stability. Samples of each lot were stored at 95°F. for 7, 14, 25, 40 and 90 days, and at 68°F. for 3, 6, 9 and 12 months. Additional samples were stored under refrigeration for use as controls. Doughnuts were selected as the product in which to test the quality of the yolk solids. Performance was evaluated on the basis of fat content, specific volume, and eating quality of the doughnuts.

Enzyme treatment materially improved the storage stability of the egg yolk solids at 95°F., the untreated sample giving doughnuts of lowered fat content and decreased palatability as the storage time increased. Similar results were obtained in the 68°F. storage series; however, the differences were much smaller than in those stored at 95°F.

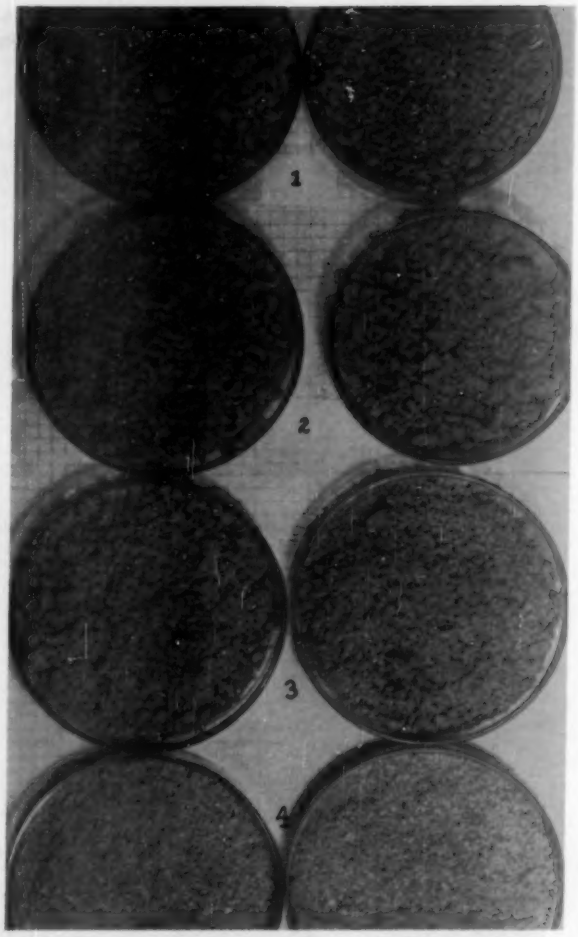

Figure 3. Dried ground doughnuts: (from top to bottom) (1) stabilized control; (2) unstabilized control; (3) stabilized, stored 90 days at 95° F.; (4) unstabilized, stored 90 days at 95° F.

Acknowledgment

The authors wish to express their appreciation to Mr. B. L. Sarett, Vita-Zyme Corp., for financial assistance, and to the Doughnut Corporation of America for the use of the doughnut machine and the test mixes. We are indebted to Mr. Larry Jenks of this firm for advice on commercial methods of doughnut preparation and for analysis of the doughnut mixes, to Dr. Richard Forsythe and Dr. Dwight H. Bergquist, Henningsen, Inc., for supplying the egg yolk solids and the analytical data, and to Mrs. Charlotte Sorenson for assistance with the fat and moisture analyses.

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Fractionation of Wood Smoke and the Comparison of Chemical Composition of Sawdust and Friction Smokes

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SMOKING OF MEAT and meat products, a comon and very old process, is one of the best ways to keep food from spoiling. Wood smoke contains substances that inhibit the growth of spoilage organisms, it improves the keeping quality of the product, and it imparts an agreeable taste and appearance to foods. In spite of the fact that the smoking process is widely used in modern packing plants, very little work has been reported on the smoke itself, on the nature and characteristics of the various components in smoke, and on the part they play during the smoking process. Although a great deal of attention has been devoted to tar and pyroligneous acid, not much is known with certainty as to the chemical nature of wood smoke and the reactions which take place during the smoking process.

Pettet and Lane *(10)* were able to study the chemical composition of wood smoke by progressively cooling the smoke to a low temperature and collecting samples in a series of traps. They have also described the construction of a pilot plant for generation and collection of wood smoke. Tucker *(13)* determined phenols in smoked meats and found, depending on the distance from the surface, that smoked meat contained from less than 0.03 to about 1.9 mg. of volatile phenols per 100 g. of meat. Linton and French *(9)* used the determination of phenols to measure the rate and extent of smoke deposition on fish. Guinot *(5, 6)* has described a process for smoking meat from pyroligneous liquors. Watts and Faulkner *(14)* have studied the antioxidant effects of four commercial liquid smokes. Colgin *(3)* subjected the condensed wood smoke or pyroligneous liquid to a refining process, whereby the deleterious substances were removed and the agreeable components which impart smoke taste and flavor were retained. This refined pyroligneous liquid was then applied to meat.

It was the object of this study to analyze, fractionate, and classify smoke into desirable and undesirable components, and then to compare the chemical composition of wood smoke generated by different methods. The findings are herein reported.

EXPERIMENTAL

Preparation of the samples. A sample of sawdust was collected from the plant, mixed thoroughly in order to make the sample as homogeneous as possible, and stored in a container for laboratory use. This procedure was used in order to have the same sample of sawdust for laboratory use and thus to preclude variations in the samples from time to time. Moisture content of this sample was 9.2%, determined by drying in an oven at 105° C. for 8 hours.

A small laboratory smoke generator was constructed from an iron pipe 36 in. x 3 in. Mosture content of the sawdust was brought to 50% by adding a calculated amount of water. The sawdust was loosely packed in the pipe. A stream of air with 1–2 p.s.i. was introduced at the bottom of the pipe, thus assisting in combustion and the production of a flow of smoke. The sawdust was allowed to burn from the top. Smoke thus generated was condensed in a train of 4 traps immersed in a mixture of alcohol and dry ice at —80° C. Condensate thus obtained was used for chemical analyses. This type of smoke will be referred to throughout this paper as "sawdust smoke."

Smoke generation by friction generator. A small friction smoke generator was constructed in the laboratory using the same principle of generating smoke by friction as in the Spiehs Smoke Generator *(12)*. Rectangular blocks of maple wood, 6 in. x 1.5 in x 1.5 in. in size, were used to generate smoke. Blocks were held in position against a rotating metal disc by applying compressed air. Pressure could be adjusted in accordance with amount of smoke desired. This smoke was also condensed at —80° C. and in the same manner as described for sawdust smoke. This type of smoke will be referred to as "friction smoke."

Determination of volatile acids. Approximately 30 g. of the smoke condensate were weighed accurately in the Erlenmeyer flask and steam distilled for 45 minutes. Steam distillate and non-steam volatile fraction remaining in the distillation flask were titrated with standard sodium hydroxide solution using phenolphthalein as indicator. This gave the amount of total acids in the steam distillate as well as in the non-steam volatile fraction.

Chromatography of volatile acids. A slight excess of alkali was added to the steam distillate in order to be sure to convert all the acids into their sodium salts. Distillate was then transferred quantitatively into a 1,000-ml. volumetric flask and made up to volume with distilled water. An aliquot of 25-50 ml. of the steam distillate was carefully evaporated to dryness in an Erlenmeyer flask. Acids in the residue were liberated from their sodium salts by a slight excess of sulfuric acid. Care was taken that the acid wetted all the residue particles, and that the total volume of the acid added did not exceed 0.5 ml. Sulfuric acid 4 N or 8 N was used, depending on amount of acids present and sodium hydroxide used. Approximately 1 g. silicic acid was then added to adsorb all the liberated acids. The thick paste of silicic acid thus obtained was transferred quantitatively into a micro extraction thimble, using each time 2–3-ml. portions of ethyl ether for rinsing. If the volume of sulfuric acid used to liberate acids exceeded 0.5 ml., ethyl ether did not come in contact with silicic acid. Acids were extracted for 4 hours in a micro Soxhlet extractor, using ethyl ether as solvent. After extraction was complete, 5–6 ml. of distilled water was added to the ether and extracted acids were neutralized with sodium hydroxide; a slight excess of alkali was added with vigorous shaking to convert all the free fatty acids into their sodium salts. The 2 layers were then separated, the ether layer was washed 3 times with 5-ml. por-

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tions of distilled water and the ether discarded. The portions used to wash the ether layer were added to the main aqueous layer, which was then evaporated to dryness in an Erlenmeyer flask. The residue contained the sodium salts of steam volatile acids.

Acids were liberated from their corresponding sodium salts by adding slight excess of 4 N or 8 N sulfuric acid, care being taken that total volume of sulfuric acid added did not exceed 0.5 ml., and that all particles of the residue were wetted by the sulfuric acid. Approximately 1 g. of silicic acid was added to the liberated acids, and the resulting mixture was transferred quantitatively to the top of the silicic acid chromatographic column, using 3-ml. portion of chloroform each time for rinsing.

Chromatographic separation of component acids. Procedure used for the chromatographic separation of these acids was a modification of the methods of Ramsey and Paterson *(11)* and Bulen, Varner, and Burrell *(2)*. Preparation of silicic acid for chromatography, preparation of the chromatographic column, and of the eluting solvents were exactly the same as described by Bulen *et al. (2)*. Solvents were prepared from chloroform and n-butanol to contain 1, 5, 15, and 25% (V./V.) n-butanol in chloroform. All solvents were equilibrated against 0.5 N sulfuric acid before use. The solvent schedule was 120 ml. of chloroform, 100 ml. of 1%, 100 ml. of 5%, 100 ml. of 15% and 100 ml. of 25% n-butanol in chloroform.

Pressure in the chromatographic column was adjusted so that effluent was collected at the rate of 80 ml. per hour. Five ml. of effluent were collected in each fraction. Each fraction was titrated with 0.010 N sodium hydroxide using phenol red as indicator. The order in which the acids were eluted from the column was as follows: butyric, propionic, acetic, formic, and an unidentified acid fraction.

A graph was plotted of the number of fractions versus volume of 0.010 N sodium hydroxide used. Each of the above acids gave a well-defined peak on this graph. After titration of each fraction, fractions pertaining to each individual acid were combined together and kept for further identification of these acids by preparation of their derivatives.

A known mixture of butyric, propionic, acetic and formic acids was run through the column in an identical manner. A graph was plotted of the number of fractions versus volume of 0.010 N sodium hydroxide used. The position of each acid, represented by individual peaks as they were eluted from the column, was carefully marked on this graph. By comparing this graph with the graph of the unknown sample, acids in the unknown sample were identified tentatively. Further identification of each acid was achieved by preparation of the derivatives according to the method of Ramsey and Paterson *(11)*. The recovery of the acids varied from 90 to 95%.

The unidentified acid fraction contained 2 acids which were only partially separated. On re-chromatography of this fraction over silicic acid column, complete separation of the 2 unidentified acids was effected.

The 2 unidentified acids were converted into their ammonium salts. Ammonium salts were then chromatographed on paper according to the technique of Isherwood and Hanes *(8)* using a mixture of 7 parts by volume of n-propanol and 3 parts by volume of concentrated aqueous ammonia. Chromatograms were allowed to develop for 5½ hours, and then sprayed in CO_2 free atmosphere with 0.1% aqueous thymol blue solution. Ammonium salts of several known acids were also chromatographed in a similar manner in an effort to identify these 2 unknown acids.

Determination of phenolic compounds. Total steam volatile and non-steam volatile phenolic compounds, after their extraction according to the scheme of Braus, Middleton and Ruehhoft *(1)* were determined colorimetrically by a modification of the 4-aminoantipyrine method of Ettinger, Ruehhoft and Lishka *(4)*. The phenolic compounds thus extracted were made to a known volume with ethyl ether. Aliquots of 1 to 5 ml., depending on the concentration of phenols, were taken and to each of the aliquots the following reagents were added in the same order as stated:

One hundred milliliters H_2O, 1.2 ml. 6 N NH_4OH to give a pH of 9.8 to 10.2, 1 ml. 3% aqueous solutions of 4-aminoantipyrine, and 10 ml. 2% potassium ferricyanide solution. The mixture was then extracted with chloroform and the extract made to 100 ml. with the same solvent. Two blanks and 4 standard solutions containing varying amounts of pure phenol were treated in exactly the same manner. The color was compared in a Beckman Model DU Spectrophotometer at 460 mμ. A graph was plotted of the optical density at 460 mμ versus concentration of phenol in the standard solutions. The concentration of the unknowns was determined by reference to this graph.

Determination of carbonyl compounds. An aliquot of each of the steam distillate and of the non-steam volatile fraction was used to determine total carbonyl compounds gravimetrically as 2,4-dinitrophenyl hydrazones according to the technique of Iddles and Jackson *(7)*.

Determination of water. Water was determined on the smoke condensate, obtained by condensing smoke at −80° C., by distilling a known weight of the smoke condensate with 150 ml. xylene previously saturated with water. The volume of water collected was measured directly.

Fractionation of smoke. A series of experiments were run in which sawdust smoke was partially condensed and fractionated by passing through a train of 4 condensers at one of the following temperatures of −18° C., −5° C., 4° C. and 15° C. for each separate run. Over 90% of the condensate collected in the first 2 condensers. The uncondensed portion of the smoke was used to smoke pieces of cured hog bellies, 110–115 g., in a small smoke house fitted with a thermometer, inlet for air, inlet for smoke, and a recirculating pump. Pieces of cured hog bellies were first heated for half an hour at 125° F. and then smoked for 4 hours at the same temperature. The smoke condensates obtained by condensing smoke at each of the temperatures of −18° C., −5° C., 4° C. and 15° C. were steam distilled separately using steam equal to 800 ml. per hour and the distillate used for smoking. The steam introduced in the smoke condensate carried with it steam volatile components from the latter in the smoke house. Pieces of cured hog bellies were smoked in the same manner with the steam distillates from each of the above smoke condensates. At the end of the smoking process, pieces were removed, cooled, sliced and fried for taste panel studies.

The non-steam volatile fractions of the smoke condensates (fractions of smoke remaining after steam distillation) were combined together and the pieces of belly were immersed in this mixture and kept in the smoke house for 4 hours at 125° F. A slow stream of air was introduced into the mixture while in the smoke house in order to provide adequate agitation. The product was then cooled, sliced and fried.

RESULTS AND DISCUSSION

On steam distillation of the smoke condensate it was observed that all the odor and flavor of smoke passed over in the distillate, while the fraction remaining in the distilling flask retained almost all of the dark brown color but practically no smoke odor and flavor. The steam distillate had a very light color but most of the characteristic smoke flavor. This indicates that compounds responsible for characteristic smoke flavor are steam volatile. On titrating both non-steam volatile fraction and steam distillate for total acidity, it was found that the steam distillate contained most of the acids.

The sawdust smoke as condensed in an alcohol and dry ice bath at −80° C. was dark brown pungent-smelling material which completely solidified at this temperature. Friction smoke, on the other hand, was deep orange, sweet-smelling, semi-solid material at this temperature. Results for the chemical analysis of friction and sawdust smokes are presented in Table 1. Each figure represents an average of duplicate de-

terminations. It can be seen from Table 1 that friction smoke, when compared with sawdust smoke, contains less moisture, 4 times more steam volatile acids, and 8 times more steam volatile aldehydes and ketones. It is interesting, however, that the amount of non-steam volatile acids is practically the same in the 2 types of smoke. The amount of steam volatile phenolic compounds is also greater in the friction smoke. Data in Table 1 indicate clearly that friction

TABLE 1

Distribution of steam volatile and non-steam volatile compounds in condensed sawdust and friction smokes

No.		Saw Dust Smoke		Friction Smoke	
		Steam Volatile	Non-Steam Volatile	Steam Volatile	Non-Steam Volatile
1	pH	4.00	4.20	3.18	3.00
2	Total acids (as acetic acid)	1.28%	0.183%	4.98%	0.209%
3	Total aldehydes and ketones (as acetaldehyde)	0.627%	0.164%	4.78%	2.79%
4	Total phenolic compounds (as phenol)	0.068%	0.007%	0.217%	0.067%
5	Moisture	86.7%		70.6%	

smoke contains a much greater amount of steam volatile compounds than sawdust smoke. As stated above, steam volatile compounds for the most part are responsible for the characteristic smoke flavor.

Table 2 gives the results of the chromatographic separation of steam volatile acids of condensed friction and sawdust smokes. Except for butyric and propionic acids, friction smoke contains a far greater amount of these acids than sawdust smoke. In both types of smoke acetic acid occurs in the greatest amount, formic acid being next in order of the amount present. The order in which the steam volatile acids are eluted from the chromatographic column is presented graphically in Figure 1, where the number of 5 ml. fractions of effluent is plotted against the volume of 0.0108 N. sodium hydroxide used for the titration of each fraction. The graph presented in Figure 1 is for the friction smoke. (The 2 peaks for

TABLE 2

Chromatographic separation of steam volatile acids of condensed sawdust and friction smokes

No.		Saw Dust Smoke	Friction Smoke
		mg. acid/100 g. smoke	mg. acid/100 g. smoke
1	Butyric acid	24.17	22.42
2	Propionic acid	80.31	52.36
3	Acetic acid	1001.	3743.
4	Formic acid	177.4	837.6
5	Unidentified Acid I (as acetic acid)	30.17	178.6
6	Unidentified Acid II (as acetic acid)	31.28	185.2
7	Total acids recovered by chromatography	1344	4841
8	Total acids found by direct titration (as acetic acid)	1280	4980

acetic acid are due to the change from 1% to 5% of the eluting solvent. This change takes place on the descending side of the main acetic acid peak, and hence a second smaller peak for the same acid is obtained.) An exactly similar curve is obtained in the case of sawdust smoke. It can be seen from Figure 1 that the 2 unidentified acids are eluated from the column soon after formic acid with 15% n-butanol in chloroform solvent. A comparison of Nos. 7 and 8 in Table 2 indicates a close agreement between total amount of acids recovered by chromatography and amount of total acids as determined by direct titration of the steam distillate. This shows that all of the steam volatile acids chromatographed on the silicic acid column were completely recovered.

Ammonium salts of 30 known acids were chromatographed on paper according to the technique of Isherwood and Hanes *(8)* in an effort to identify the 2 unknown acids. The R_f values of the 2 unidentified

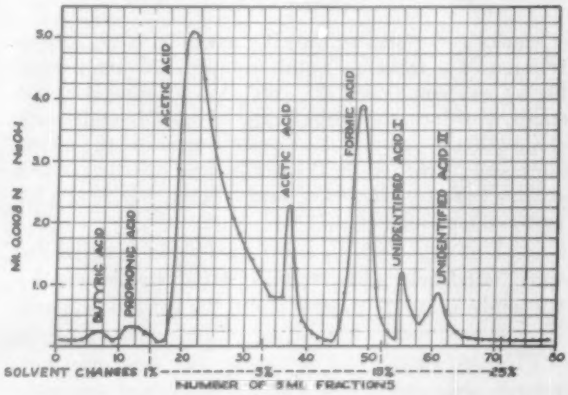

Figure 1. The chromatographic separation of steam volatile acids of condensed friction smoke.

acids were found to be 0.049 and 0.048, respectively. The 2 unidentified acids showed no maximum or minimum absorption in the visible and the ultraviolet range of the spectrum. Of the known acids *a*-ketoglutaric, tricarballylic and aconitic acids were found to have the same R_f values as the 2 unidentified acids. It is possible that some of these acids may be present in smoke in the form of their volatile anyhydrides, which on steam distillation and subsequent extraction are converted to free acids.

Fractionation of sawdust smoke was performed by passing it through a train of condensers at one of the temperatures of —18° C., —5° C., 4° C. and 15° C. for each separate run. Smoking the pieces of cured hog bellies with the condensable and non-condensable portions of smoke at the above temperatures was undertaken with a view to determining the effect of this fractionation on bacon. It was observed that the bacon smoked with the non-condensable portion of smoke at —18° C. and —4° C. lacked characteristic smoke flavor and color. This was because, at these temperatures, most of the desirable as well as the

undesirable components in smoke were being condensed and hence the portion of smoke that passed through was poor in the desirable components. On the other hand, smoking of bacon with the non-condensable portion of smoke at 4° C. and 14° C. resulted in a satisfactory product. Bacon smoked by steam distillation of the condensable portion of smoke at any of the above temperatures did not differ very much from one another. It was slightly lighter in color than the bacon of regular production in the plant, and possessed a pungent and biting taste. The portion of smoke which remained after steam distillation was also used for smoking pieces of cured hog bellies. Bacon thus prepared was black at the edges and in general possessed a very disagreeable appearanee and taste. These observations suggest that the undesirable compounds in smoke are not steam volatile and that they can be successfully separated from the desirable components by cooling smoke to a suitable temperature.

SUMMARY

Smoke generated by burning sawdust as well as by friction of a rotating metal disc against small wood blocks was condensed at —80° C. and analyzed. On steam distillation of either type of smoke condensate, the distillate was found to contain most of the smoke odor and flavor, while the non-steam volatile portion retained most of the dark brown color, but negligible smoke odor and flavor.

Most of the acids in sawdust and friction smokes were found to be steam volatile. Of all the steam volatile acids, acetic acid occurred in the greatest amount. Formic acid was next in order of the amount present.

Friction smoke was richer in the desirable compounds than sawdust smoke. It contained less moisture, four times more steam volatile acids, and eight times more steam volatile aldehydes and ketones than sawdust smoke. Steam volatile phenolic compounds were also greater in the friction smoke. The non-steam volatile portion of either type of smoke was found to be very undesirable for smoking of bacon.

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Use of Glucose Oxidase to Stabilize Beer

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FOR MANY YEARS brewers and scientists serving the brewing industry have been aware of the deteriorating effects of oxygen on the flavor and shelf life of beer. Some reduction in the amount of oxygen included (in air) in beer has been attained by mechanical means in the packaging process, and recently an attempt has been made to prevent inclusion of air chemically. While these efforts have resulted in processing improvements, none of them is completely successful.

The glucose oxidase-catalase system *(1)* (hereafter referred to as "glucose oxidase") which has already been applied on a large scale in the egg processing and allied formulated food industries, *(2)* is the tool which the brewer can use to control oxidation and put an end to it when its useful functions have been completed. This enzyme system continues to be active from the time it is added to the beer until the beer is consumed, and its action is even enhanced by some of the beer processing steps. By virtue of its being a system of enzymes, the required amounts are minute. The amount needed to stabilize average beers is only 1 ml. of the liquid or ½ gram of the powdered enzyme per barrel of beer.

THE GLUCOSE OXIDASE-CATALASE SYSTEM

In order to facilitate understanding the specific factors involved in the glucose oxidase system, some of its pertinent characteristics will be developed.

The enzyme system contains glucose oxidase and catalase. The former catalyzes the oxidation of glucose to gluconic acid and hydrogen peroxide, according to the equation:

$$2\ H_2O + 2\ \text{glucose} + 2\ O_2 \xrightarrow{\text{glucose oxidase}} 2\ \text{gluconic acid} + 2\ H_2O_2$$

The catalase then breaks down the hydrogen peroxide to water and oxygen. (As hydrogen peroxide is an oxidizing agent and its presence would bring about the same deleterious effects as free oxygen, it must be destroyed). This is accomplished by the catalase, which catalyzes its breakdown, according to the equation:

$$2\ H_2O_2 \xrightarrow{\text{catalase}} 2\ H_2O + O_2$$

Thus the net reaction for the enzyme system is:

$$2\ \text{glucose} + O_2 \xrightarrow[\text{catalase}]{\text{glucose oxidase}} 2\ \text{gluconic acid}$$

The glucose oxidase (containing catalase) used in all experiments was a commercial product, which is packed both as a dry white powder and as a clear amber solution. The powder contains 1500 Sarett units* per gram, and has isoelectric point at 4.37 and specific gravity (in 2% solution) of 1.01135. The solution contains 750 Sarett units per ml. and has specific gravity 1.1699. The optimum pH range is 4.5 to 8.0 but it is still very active below and above this range. The optimum temperature activity range is 20 to 60°C, with increasing activity as the temperature increases up to a limit where it is rapidly denatured, at 87°C.

Figure 1 shows the relationship of activity of glucose oxidase to temperature over the range of 0° to 60°C. In calculating the values in the chart, the activity at 0°C. was arbitrarily taken as 1.0, and the change in activity over each 10°C. interval was measured. The number of Sarett units for each of the points is also noted on the chart. Chart 1 shows that the activity at 30°C. is almost double that at 0°C. and the temperature range corresponding to the most efficient action of the enzyme in 20-60°C (68-140°F), which is the range within which beer is processed and distributed.

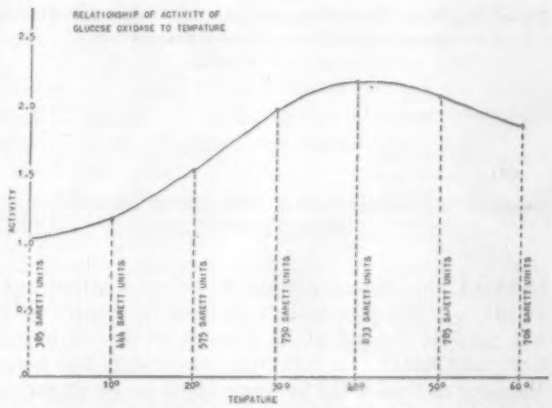

Figure 1. Relationship of activity of glucose oxidase to temperature.

Figure 1 may also be used to determine the time required for a given amount of oxygen in beer to react with the glucose present. For example, assuming that the beer contains 5 cc. of air and the average temperature is 30°C., the time required for the oxygen to react is about 15 hours, assuming that all of the oxygen is in solution. As undissolved oxygen does not participate in the reaction with glucose nor in the oxidation of the beer, the 15 hours can be considered to be the maximum time necessary to remove potentially harmful oxygen.

A common belief among brewers is that beer does not contain any glucose. If this were true, the glucose oxidase would have no effect whatsoever. It is true that for most practical purposes glucose is absent from beer. However, a trace of glucose is sufficient to allow the enzyme system to function and bind all of the oxygen normally present in beer. For example, the presence of only 0.001% glucose is equivalent to 35.9 mg. in a 12 oz. bottle, and only 31.5 mg. are required to remove the oxygen from 10 cc of air, which is about 5 times as much as is normally present. In order to demonstrate the presence of glucose in sufficient amount, chromatograms were made on 12 finished commercial beers to determine the sugars present. In all cases glucose was found either in measurable or in immeasurable amounts, but identified by a specified position or migration spot on the chromatogram.

USE OF GLUCOSE OXIDASE IN UNPASTEURIZED (DRAUGHT) BEER

Some beers that are to be consumed within a short time after bottling are not pasteurized. Such beers must be handled carefully and must be kept chilled until used; otherwise they will spoil quickly because

* A Sarett unit is defined as that quantity of enzyme which will cause an oxygen uptake of 10mm³ per minute under specified conditions and on a specific substrate *(5)*.

of the rapid growth of yeasts. In the presence of oxygen, yeast cells live on the fermented alcohol present in the beer. As the yeast count increases so does the haziness and precipitation, and it is undoubtedly the growth of these yeast cells which results in quick spoilage of beer. In the absence of oxygen yeast cells will not grow readily on alcohol. Beer that is not to be pasteurized will therefore keep its good flavor for a longer period of time if it is deoxygenated. Unpasteurized beer usually spoils at room temperature in 7 to 12 days. Under refrigeration ½ gallon will usually go bad in 30 days.

The results of comparative tests on glucose oxidase treated and untreated unpasteurized beer are shown in Table 1. For these tests the yeasts and molds were

TABLE 1

Effect of glucose oxidase on the growth of yeast and mold in unpasteurized beer at room temperature

Total yeasts and molds per cc.

Sample	Days Elapsed				
	0	28	35	43	50
Unpasteurized glucose oxidase treated beer	0	4	15	18	30
Unpasteurized untreated beer	37	3,200	9,200	20,000	Hazy (milky)

cultured by dilution plating in potato-dextrose agar at pH 3.5. The treated beer at *room temperature* did not spoil at the end of 50 days, as evidenced by the low yeast count. In fact, the yeast count was about the same as that of the untreated beer at the beginning of the test period. Its appearance and taste were also unchanged. After the 50th day, however, the yeast count increased very rapidly. Under refrigeration, of course, the treated beer could be kept for a much longer time.

USE OF GLUCOSE OXIDASE IN PASTEURIZED BEER

An even more significant aspect of the use of glucose oxidase for the brewer to consider is its effectiveness in decreasing the amount of free oxygen during pasteurization and prolonged storage. Beer is pasteurized mainly in order to inactivate the yeasts and prevent spoilage caused by their growth. However, pasteurization does not remove oxygen; hence oxidation can continue unhindered, although at a slower rate than the growth of yeasts.

The air present (mostly in solution) in unpasteurized and pasteurized beer is the chief source of the oxygen causing the undesired oxidation reactions. To substantiate this fact, the amount of residual oxygen in beer before and after pasteurization was determined in untreated samples and in samples treated with glucose oxidase. In order to present a clearer picture, all of the samples purposely contained a greater than normal quantity of air (6 to 8 cc. as opposed to the normal 1.5 to 2 cc. per 12 oz. bottle). While this greater quantity increased the total amount of oxygen present, the ratio of oxygen to air (0.19) remained unchanged so that the results illustrated are strictly comparable to those for beer containing the normal amount of air. The results of these tests are shown in Table 2. This table shows that the ratio of oxygen to air decreased by a greater amount in the untreated than in the treated beer during pasteurization. In other words, addition of glucose oxidase to beer decreases oxygen consumption, and consequently the extent of oxidation reactions, during pasteurization. Furthermore, oxygen consumption in the treated beer can be ascribed primarily to the reaction of oxygen with glucose rather than to oxidation of substances essential to the quality of the beer. In this connection it should be recalled that the activity of glucose oxidase at the pasteurization temperature of 60°C (140°F) is only slightly lower than its activity at the optimum temperature of 40°C.

Even more important is the fact that the glucose oxidase has already bound a substantial portion of the oxygen before pasteurization, as evidenced by the lower oxygen to air ratio in the treated beer before pasteurization. The lowering of the ratio in the untreated beer shows that the oxidation reactions which result in shorter shelf life of the beer are initiated during pasteurization itself.

Table 2 also shows the results of another measurement of oxidation, the Indicator-Time Test, or ITT[b], carried out with the same samples of beer. This test indicates the reducing action of the beer, so that if some of the oxidizable substances, such as protein, have already been oxidized, the reducing action will be decreased and the ITT value will be higher. This test is not an absolute standard, but is a relative measure of the state of oxidation of a beer, and is included here and in later tables and charts because of its common usage in the brewing industry. This test leads to the same general conclusion as the oxygen to air tests, namely that oxidation both before and during pasteurization is significantly lower in the beer treated with glucose oxidase than in the untreated beer.

Despite its limitations, Wallerstein's ITT is the only published accepted method for estimating the shelf life of beer. Heat and shaking methods have been tried, but in these the oxidation is both physical and chemical rather than purely chemical, and correlation with results obtained on normal handling is poor. These methods cannot be used reliably to predict whether a beer will last 2 months or 6 months. However, by dividing the beer proteins into fractions according to molecular weight [Lundin Fractions

TABLE 2

Oxygen content and reducing action of untreated beer and beer treated with glucose oxidase, before and after pasteurization

Sample		Ration oxygen/air		ITT Values (sec.)	
		Range	Average	Range	Average
Untreated	Before pasteurization	.18-.20	.19	178-270	225
	After pasteurization	.09-.123	.106	300-600	500
Treated	Before pasteurization	.085-.112	.10	150-240	200
	After pasteurization	0-.10	.07	175-280	255

[b] The ITT value is the time in seconds required for a given quantity of sample to decolorize 80% of the added indicator, as judged by comparison with suitable standards. See ref. (*6*).

(4)] and determining their relative amounts as the oxidation progresses, one can soon develop a set of coefficients. This method is based on the fact that the protein equilibrium is a function of the amount of oxygen present. It has been found that as oxidation takes place the protein equilibrium tends to swing from lower to higher molecular weight proteins. Thus the distribution of proteins in the high, medium and low molecular weight fractions is a measure of the degree of oxidation. The simplest way of expressing the degree of oxidation as evaluated by this method is by noting the percent of the total protein which is in the high molecular weight fraction.

The data in Table 3 show a comparison of the protein analysis to several other commonly used tests for degree of oxidation of beer. The tests were carried out on beers from a number of different breweries (A, B, etc). The test referred to in the table as "Chilled at 32°F." is a visual analysis carried out by cooling the beer to 32°F. for 24 hours, then pouring it into a glass and measuring the amount of haze by looking through the glass with the light placed in such a manner as to give the Tyndall effect. The beers were classified into 5 categories—*brilliant, clear, slighty hazy, hazy,* and *very hazy.* The familiar ITT values, which are used as a criterion in most breweries, are also included in Table 3. The table shows that the visual examination after chilling, the percent of total protein in the high molecular weight fraction and, in most cases, the ITT value are in general agreement, and that as the ITT increases, so does the percent high molecular to total, and also the haze in the beer. For example, in comparing brewery D to brewery J, in the former the ITT is 1000″ as compared to 400″ in the latter, the percent high molecular to total protein is 33.10 as compared to 10.00 and the appearance is hazy as compared to brilliant. Comparison of breweries B and G shows the same relationship—increase in the turbidity and haziness and loss of brilliance accompanied by increase in ITT values and high molecular weight proteins—as oxidation increases.

TABLE 3

Comparison of several tests for evaluating the extent of oxidation in beer

Brewery	ITT, sec.	Chilled at 32°F	Proteins, %				
			Total	High Molecular	Medium Molecular	Low Molecular	% High to Total
A	417	V. Hazy	0.420	0.138	0.189	0.088	32.85
B	188[1]	Brill.[1]	0.320	0.055	0.138	0.122	17.16[1]
C	328	Brill.	0.240	0.031	0.075	0.0856	12.99
D	1000[1]	Hazy[1]	0.281	0.093	0.0985	0.056	33.10[1]
E	467	Hazy	0.348	0.122	0.1255	0.090	35.10
F	371[1]	V. Hazy[1]	0.336	0.103	0.141	0.093	30.62[1]
G	1240[1]	Hazy[1]	0.315	0.100	0.114	0.101	31.71[1]
H	1000	V. Hazy	0.335	0.097	0.116	0.091	28.95
I	800[1]	Brill.[1]	0.385	0.057	0.183	0.145	14.80[1]
J	400[1]	Brill.[1]	0.330	0.033	0.117	0.080	10.00[1]

[1] Discussed in text.

The values for breweries F and I, on the other hand, show the inadequacy of the ITT as an absolute standard. For F, in spite of the low ITT, the hazy appearance and the percent high molecular to total protein indicate considerable oxidation, while for I the high ITT is in disagreement with other tests. These discrepancies can be accounted for by differences in the brewing process, resulting in different initial ITT values. While the ITT is a reliable indication of the progress of oxidation in a single beer, it is not an absolute standard for comparing one beer to another.

In the case of pasteurized and unpasteurized beer, the oxidation taking place during pasteurization can likewise be measured by means of the protein molecular distribution. For example, in the case of the untreated and the glucose oxidase treated beer used to collect the data in Table II, the percent of total protein in the high molecular fraction was 14.26% before pasteurization and 18.00% after pasteurization, for the untreated beer, while it was 13.7% before and 14.95% after pasteurization for the beer treated with glucose oxidase. Here too the protein test confirms the results of the oxygen/air ratio and the ITTs. This procedure for measuring oxidation is being developed further so as to give a more detailed elucidation of oxidation problems and the results will be presented in a later paper.

OPTIMUM TIME FOR ADDING GLUCOSE OXIDASE TO BEER

Although controlled oxidation is mandatory in brewing from beginning to end, glucose oxidase should not be added to beer until after fermentation. The yeast used to ferment wort to beer possesses an intricate method of manufacturing oxygen over and above that which is dissolved in the wort, the system being either by enzymatic action or by pigmentation or both. The yeast converts glucose and oxygen into ethyl alcohol and carbon dioxide, whereas glucose oxidase converts these same subtrates into gluconic acid. Both systems are very specific and therefore the glucose oxidase would be in direct competition with the yeast and decrease its efficiency for the fermentation.

In order to substantiate this theory, experiments were carried out to compare the oxygen uptake of yeast with that of glucose oxidase. It was found that the average amount of oxygen taken up by 1 mg. of yeast (on a dry weight basis) was 83.4 mm^3 per hour. As both this determination and the determination of glucose oxidase potency in Sarett units are based on pressure drop as measured in the Warburg manometric apparatus, and differ only in the definition of the units of measurement, the oxygen uptake of the yeast can be calculated as Sarett unit equivalents. The uptake of 83.4 mm^3/hr./mg. is equivalent to 140 Sarett units per gram, as compared to a potency of 750 Sarett units for 0.5 g. powdered or 1 ml. liquid glucose oxidase.

The oxygen uptake of yeast and glucose oxidase is shown in Figure 2. Bearing in mind that 1 gram of dry yeast is equivalent to 5 grams of pitching yeast, it can be seen that liquid glucose oxidase has about 25 times the activity, and powdered glucose oxidase about 50 times the activity of yeast.

However, when glucose oxidase is added to beer after fermentation is complete, it can no longer

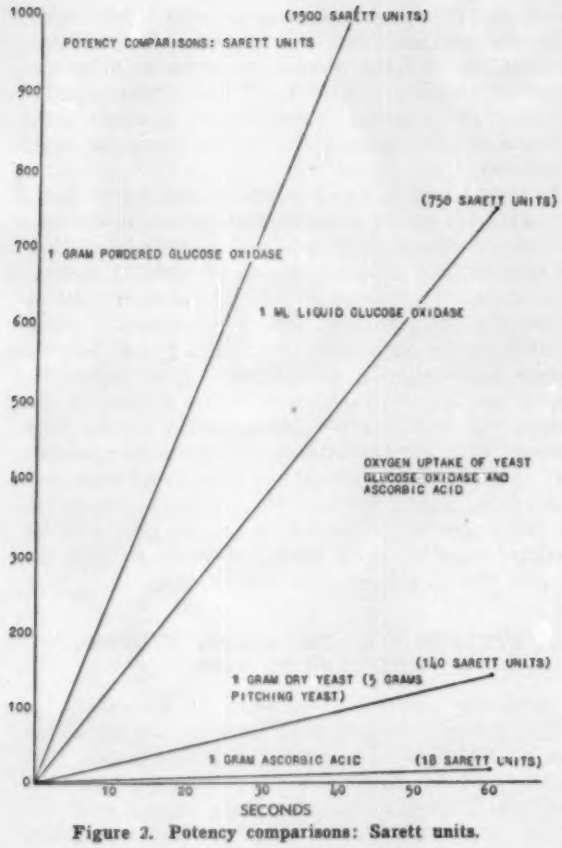
POTENCY COMPARISONS: SARETT UNITS
(1500 SARETT UNITS)
(750 SARETT UNITS)
1 GRAM POWDERED GLUCOSE OXIDASE
1 ML LIQUID GLUCOSE OXIDASE
OXYGEN UPTAKE OF YEAST GLUCOSE OXIDASE AND ASCORBIC ACID
(140 SARETT UNITS)
1 GRAM DRY YEAST (5 GRAMS PITCHING YEAST)
1 GRAM ASCORBIC ACID
(18 SARETT UNITS)
SECONDS

Figure 2. Potency comparisons: Sarett units.

interfere with this important process, and prevents continuation of oxidation beyond the desired point. In other words, the glucose oxidase should be added to the beer as soon after fermentation as is practical in the regular processing procedure.

IRON PICKUP

The discussion up to now has been primarily concerned with the effects of oxidation on bottled beer. The same effects are noted in canned beer, but here another complication factor is present; namely, iron pickup from the can. Iron pickup is dependent on the presence of oxygen, and the greater the amount of oxygen present, the greater will be the amount of iron passing into the beer, if all other factors (can lining, etc.) are constant. Furthermore, once the process has started, the iron oxide in the beer acts as a catalyst and accelerates continued iron pickup.

In order to show the effect of oxygen on iron pickup and the inhibiting effect of glucose oxidase on this phenomenon, a series of comparative tests were run on 2 groups of samples of canned beer. One group had the normal air content of 1.50 to 2.00 cc. per 12 oz. can, while the other was purposely taken so as to have a high air content of 4 to 8 cc. per can. Glucose oxidase was added to half the samples in each group, while the other half remained untreated. The ITT values (in seconds) and the iron content (in p.p.m.) were determined at intervals over a period of several months. The results for the beer samples having the normal air content are shown in Figure 3, those for the samples having high air content in Figure 4. Each point on the charts represents the average of 20 cans. It can be seen from Figure 3 that for beer with normal air content the ITT values increased slowly for the first 2 months and then increased much more rapidly while the iron content increased slowly for the first 3 months and then more rapidly. On the other hand, the ITT values of the treated beer remained practically constant over the whole test period, while the iron content increased slowly for the first two months and then levelled off. In the case of the beer samples with high air content (Figure 4) both the ITT values and the iron content of the untreated beer increased rapidly from the very beginning of the test period, while in the treated beer both increased slowly for the first 3 or 4 months and then remained essentially constant.

The increase in iron content of the untreated beer was reflected in a change in taste, and in the samples with high air content the astringent taste of iron was quite pronounced. A taste panel could detect oxidation taste in these samples after 30 days, and in the untreated samples having normal air content after 60 days. On the other hand the treated samples in both groups, after 6 months of shelf life, displayed no noticeable oxidation or iron taste.

The presence of oxygen and iron in beer, along

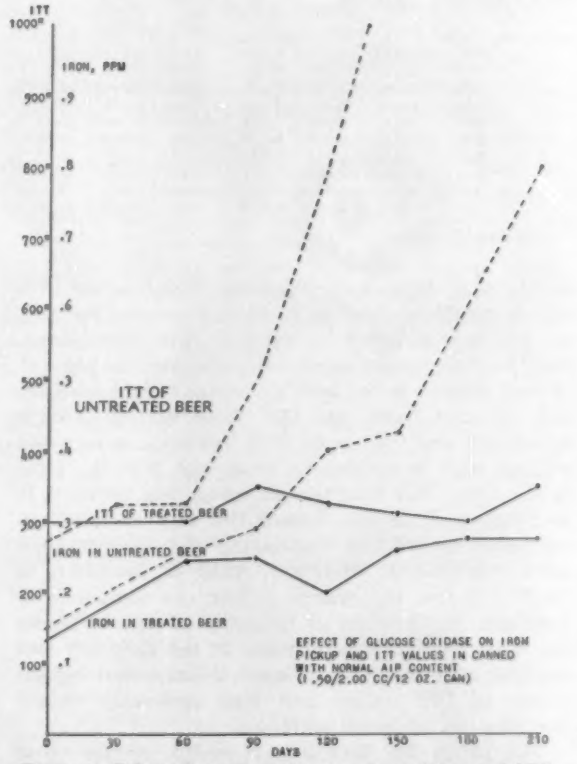
ITT
IRON, PPM
ITT OF UNTREATED BEER
ITT OF TREATED BEER
IRON IN UNTREATED BEER
IRON IN TREATED BEER
EFFECT OF GLUCOSE OXIDASE ON IRON PICKUP AND ITT VALUES IN CANNED WITH NORMAL AIR CONTENT (1.50/2.00 CC/12 OZ. CAN)
DAYS

Figure 3. Effect of glucose oxidase on iron pickup and ITT values in canned beer with normal air content (1.50-2.00 cc./12 oz. can).

LEGEND:
—— TREATED BEER
--- UNTREATED BEER

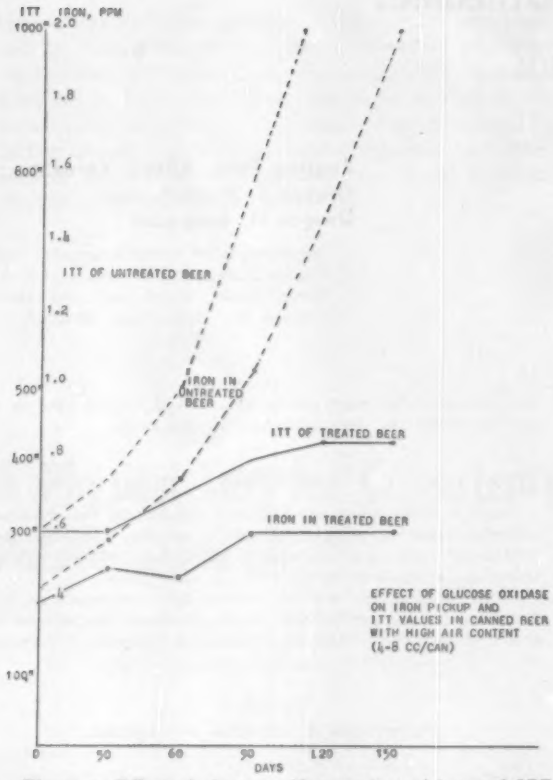

Figure 4. Effect of glucose oxidase on iron pickup and ITT values in canned beer with high air content (4-8 cc./can).

LEGEND:
—— TREATED BEER Av. Air 6–8 cc./can
– – – UNTREATED BEER Av. Air 4–5.5 cc./can

with the occurrence of the Maillard reaction, also causes a darkening of the beer on storage. The Maillard reaction *(3)* is a condensation reaction between an aldehyde group (present in glucose) and an amino group (present in proteins), and takes place more readily in the presence of oxygen. Treatment with glucose oxidase lessens the darkening of beer by binding the oxygen to glucose, decreasing the iron pickup and partially inhibiting the Maillard reaction.

A comparison of beers from the same brewery, where all constituents except the iron are as nearly equal as possible, shows that the beer containing the most iron will usually be the darkest and dullest. Likewise, with all constituents except the air equal, the beer with the higher air content will be darker. Table 4 shows the increase in color (expressed in Lovibond units) on storage of treated and untreated beers from two breweries. That from brewery A had higher initial air content. The color of the untreated beer from both breweries became markedly darker on storage, while the color of the glucose oxidase treated beer remained essentially constant. Table 4 also shows that as the color darkened the iron content and oxidation (as evidenced by the ITT values) also increased.

CONCLUSION

The foregoing discussion shows that addition of glucose oxidase to beer markedly increases its shelf life, and permits storage of both pasteurized and unpasteurized beer for longer periods of time than was previously possible. It protects the consumer from the risk of getting a beer whose appearance and taste have changed for the worse because of oxidative changes and iron pickup. The advantages to the brewer in ease of handling and in savings due to elimination of spoilage will be obvious.

TABLE 4

Effect of glucose oxidase on change of color during storage of beer containing iron and air

Days	Sample	Iron, ppm	Air, cc	ITT, sec	Color, °L
	BREWERY A				
10	Glucose Oxidase Treated	0.400	2.50	315	3.91
	Untreated	0.586	3.20	345	4.01
40	Glucose Oxidase Treated	0.450	2.60	315	3.96
	Untreated	0.700	2.80	455	4.11
70	Glucose Oxidase Treated	0.415	2.45	340	4.01
	Untreated	0.812	2.65	515	4.38
120	Glucose Oxidase Treated	0.450	1.95	400	4.01
	Untreated	1.100	3.00	980	4.63
	BREWERY B				
		Iron, ppm	Air, cc	ITT, sec	Color, °L
10	Glucose Oxidase Treated	0.178	1.58	215	3.13
	Untreated	0.280	2.13	300	3.17
40	Glucose Oxidase Treated	0.280	1.58	275	3.18
	Untreated	0.314	2.05	345	3.31
70	Glucose Oxidase Treated	0.260	1.85	480	3.21
	Untreated	0.600	1.55	600	3.61
120	Glucose Oxidase Treated	0.230	1.85	485	3.21
	Untreated	0.700	1.65	615	3.74

Note: Each analysis averaged 10 cans.

SUMMARY

Deterioration and spoilage of beer during storage are caused by oxidation reactions. The results of the deterioration are obvious to the consumer as change in taste, color and brilliance of beer. The fact that these changes are due to oxidation is substantiated by measurement of the oxygen to air ratio, the Indicator-Time Test values and the proportion of total protein found in the high molecular weight fraction.

Glucose oxidase inhibits these oxidation reactions in pasteurized beer and decreases iron pickup from the can. Its effectiveness in retarding spoilage of unpasteurized beer, by inhibiting the growth of yeast, is demonstrated. It is shown that the minute amounts of glucose normally present in beer are sufficient to enable the glucose oxidase system to function and catalyze the reaction of free oxygen with glucose to form gluconic acid.

The tests to determine the progress of oxidation with time show that treatment with glucose oxidase enables pasteurized beer to maintain brewery freshness for many months, and even makes it possible to keep unpasteurized beer without refrigeration for several weeks.

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Effects of Several Pasteurization Schedules on Performance of Egg Yolk Solids in Doughnuts

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PASTEURIZATION of egg products before freezing or drying is very effective in reducing the microbial population, especially coliforms and related types. Pasteurized egg may or may not perform well when used in the preparation of items containing egg, depending on the item in which it is used and the extent of heat treatment *(1, 3)*. The present study was undertaken to compare the effects of a series of heat treatments, all known to produce the same amount of destruction of the microbiological flora found in yolk, on the performance of yolk solids in cake-type doughnuts.

PROCEDURE

Pasteurization procedures are given in Table 1. All the liquid egg yolks were enzyme-treated to remove glucose and spray-dried as described in a previous paper *(2)*. The "sugar-free" time for replication No. 1 was 2 hours, for replication No. 2, 2¼ hours. Samples for the tests were placed in storage at −10° F. immediately after drying. They were then shipped to the laboratory where they were held under refrigeration (40–50° F.) until tested.

The functional properties of the egg yolk solids were evaluated in cake-type doughnuts. Preliminary runs showed that the procedures for preparation, baking and testing used in a previous study *(2)* were applicable in this series.

TABLE 1

Chemical and microbiological compositions of pasteurized yolk products

Liquid yolk

Location	Solids, %	pH	Color (NEPA)	Microbial Counts			
				Total	Coli	Yeasts	Molds
1	42.9	6.6	2.1	100,000	6,700	0	120
2	42.7	6.0	1.7	340,000	<100	0	40

Yolk solids

Location	Pasteurization		Moisture, %	pH	Microbial Counts			
	Temp., °F.	Time, min.			Total	Coli	Yeasts	Molds
1	140	4	2.8	6.15	2,900	<10	10	0
	142	2	2.3	6.15	2,300	<10	0	10
	144	1	2.3	6.15	2,700	<10	0	0
	146	0.5	2.5	6.15	2,100	<10	0	10
2	140	4	2.6	6.10	3,500	<10	0	40
	142	2	2.6	6.10	6,700	<10	0	10
	144	1	2.2	6.10	4,300	<10	0	10
	146	0.5	2.8	6.10	10,400	<10	0	20

RESULTS

Table 1 shows some selected data relative to the chemical and microbiological composition of the samples. Pasteurization treatments were all about equally efficient in reducing microbiological populations in the yolk, as anticipated.

Table 2 gives the results relating heat treatment of the liquid yolk to the performance in doughnuts of the yolk solids produced therefrom. Also provided is an analysis of variance of the results. The various pasteurization treatments for the liquid did not vary significantly in respect to their effects on performance of the yolk solids in doughnuts. The only significant difference related to the mixes. The two mixes gave doughnuts of different volumes and fat absorption. This is the same result noted in the earlier storage study and is the result of different flours contained in the two mixes.

TABLE 2

Performance of yolk solids in doughnuts

Type of Data	Source of Variation	Fat Content, dry basis, %	Specific Volume
Averages	Mix No. 1	30.74	3.34
	No. 2	28.47	3.19
	Location—		
	1	29.77	3.27
	2	29.44	3.26
	Replication No. 1	29.28	3.27
	No. 2	29.93	3.26
	Pasteurization		
	140°F., 4 min.	29.73	3.27
	142°F., 2 min.	29.96	3.28
	144°F., 1 min.	29.49	3.24
	146°F., ½ min.	29.24	3.27
Mean Squares from analysis of variance	Mix	41.4050**	0.1711**
	Location	0.8844	0.0005
	Replication	3.3800	0.0015
	Treatment	0.7652	0.0030
	Remainder	1.2209	0.0041

**$p < 0.01$.

The doughnuts obtained in the present study were normal in volume and were of good general eating quality. Pasteurization of the egg yolk apparently had little effect on the quality of the doughnuts.

SUMMARY

Four different time-temperature pasteurization treatments were given liquid egg yolks before drying: 140° F., 4 minutes; 142° F., 2 minutes; 144° F., 1 minute; 146° F., 1/2 minute. All these treatments

caused marked and similar reduction in bacterial counts. There was little or no difference in performance of the yolk solids in doughnuts due to treatment. Changes in fat content were not great enough to be statistically significant, or to affect appreciably the eating quality of the doughnuts. Significant difference in fat content and volume was found between the two doughnut mixes used.

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A Physical Test for Consistency of Potato Granules

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In previous studies in this laboratory *(5)*, the free soluble starch in potato granules produced by the add-back process was shown to be related to the consistency of reconstituted mashed potatoes as measured by sensory evaluation for rank number. This relationship seemed most reliable when consistency varied with degree of mechanical damage to the potato tissue. In some cases, however, other variables in the system, possibly raw material, process time, and temperature, also influenced the texture without a proportionate change in soluble starch content. Prior work on factors contributing to pastiness or to mealiness in the final mashed potatoes was cited *(5)*.

A study of the influence of ruptured cells in the granules on viscosity and a procedure for counting damaged cells with statistical interpretation of the results have been reported by Hall *(3)* and Hall and Fryer *(4)*. However, no direct correlation of consistency of mashed potatoes with viscosity or with cell count was demonstrated. In recent work by Cooley *et al. (1)* and Severson *et al. (8)*, a texture quality factor was deduced from the shape of a curve of viscosities at 6 different temperatures. Reproducibility was limited to mashes of not over 15.3% total solids.

A sensory method for consistency evaluation by comparison with reference samples, developed by Wood *et al. (9)* has been used in this laboratory for several years. Each series of not more than 4 samples is judged 3 or 4 times by 7 to 16 judges for consistency and the mean ranks, variance, and LSD are calculated. The method is used in our potato granule experimental work when a major change in the process is to be evaluated or when samples from diverse processes are compared. For control tests where only minor changes in experimental practice occur, the soluble starch or Blue Value Index is used. This index has limited reliability, as mentioned before. Although it gives positive numerical results, the former procedure *(9)* is time consuming and expensive. A study of the development of potato granule processes and a review of quality evaluation methods (subjective, chemical, and physical) have been reported by Olson and Harrington *(7)*.

Purpose of the present work was to obtain a rapid physical measurement on the reconstituted mashed potatoes, directly, that would be independent of the soluble starch content and would have a numerical relation to sensory rating by a panel of trained judges.

EXPERIMENTAL

It was found that when a ball of reconstituted potato granules was dropped to a smooth surface, the more pasty or rubbery the mash, the less the distortion on impact as shown by the diameter of the resultant cake. In order to compare different potato granule samples, it is important that the reconstituted mashed potatoes have the same solids content.

A 40-g. sample of potato granules of known moisture content was weighed on a balance graduated to 0.1 g. and then transferred to a 100-ml. beaker. The moisture content was determined by drying a 2-g. sample of granules, under 60-mesh size, for 6 hours in vacuum (3 to 4 mm. Hg at 70°C.). A mechanical mixer was installed in a 600-ml. beaker so as just to clear the bottom. A Sunbeam Mixmaster with 2 circular beater blades set at right angles and with outside diameter of 56.0 mm., operated at speed 3, 460 r.p.m., was used. The amount

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of hot distilled water to be added was calculated so that the volume in milliliters would be 4.5 times the weight of dry solids in grams, minus the moisture in the sample, in grams. Thus 40 g. of granules at 7.8% moisture would require 163 ml. of hot water. The 163 ml. of hot water, as measured, weighed 156 g. The mash then contained approximately 18.8% solids. Calculations for the volume of water to be added are as follows:

$$x = 4.5\ (40–40\ y) - 40\ y$$

where

x = volume (ml.) of water to be added
40 = wt. of the sample
y = moisture content of sample.

This reduces to

$$x = 180 - 2.2\ y \text{ when y is expressed in percent.}$$

Determination of cake diameter. In the reconstitution procedure, a 250-ml. graduate was warmed with the boiling water and the required amount was then measured, transferred to the beaker and the mixer was set going at speed 3. When the water temperature fell to 180°F., the 40-g. sample was added during 5 to 6 seconds, and beating continued for a total time of 15 seconds. The beater was removed while it was spinning in order to discharge fragments of mash, the mash surface was leveled, covered with a watch glass, and allowed to stand for 15 minutes from zero time. Condensate on the watch glass was removed once during this interval.

Three 30-g. portions of mash were weighed and each formed into a ball by rolling 30 times between the hands. Each ball was then pushed gently over the edge of a meter stick at a height of 6 feet above a smooth level surface. Aluminum trays, detergent cleaned, rinsed and dried were satisfactory. Three diameters, about 60° apart, were measured on each cake to the nearest 0.1 mm. and the mean of the 9 values calculated as the diameter of the sample. Three samples of potato granules, 40 g. each, were reconstituted for each lot being tested and the mean of 3 determined for the lot.

Comparison of reconstitution methods. *Mechanical and manual.* Perhaps the most important step in the reconstitution, after the solids ratio and temperature are established, is a means of rehydrating the potato tissue without undue additional damage to the cells.

A comparison of mechanical and manual methods was made by Cooley *et al.*, and textures estimated from viscosities *(1)*, and it was found that better texture was obtained by stirring in the powder with a fork than by beating with a mechanical mixer, since the latter tended to cause some cell damage. The former method was not employed however, because of lack of uniformity of the resulting product.

In the present work a comparative study of the two methods of reconstitution gave results that were not substantially different, considering the limits of experimental error. It was essential that this be so in order to compare the diameter test (mechanical mixing) with sensory appraisal (manual mixing), *(9)*, as will be shown later. A sample of commercial potato granules was reconstituted, mechanically, as described above, and manually by stirring with a fork—2 strokes per second for 30 seconds. Each mash was held in the beaker for 15 minutes from zero time before weighing out the three 30-g. portions for rolling and dropping. Four diameter determinations (12 reconstitutions) were made with balls originating from batches made by each of the two reconstitution methods. The results were: 64.6 mm. and 66.1 mm., by the mechanical and manual methods, respectively. Maximum deviations were 1.7% in each case.

The difference in mean diameter by the two methods is small. The lesser figure indicates that mechanical mixing may cause a little more damage to the potato cells with consequent release of more free starch, which in turn would increase the rubberiness and restrict the spread of the mass on impact.

Reproducibility of the cake diameter determination. The test was repeated, by another worker, on another sample of granules on which a number of determinations had been made and which had been stored for 8 months at 34°F. The check determination reproduced the previous results within 0.6 mm. or 1% of the original diameter of 56.9 mm.

RESULTS AND DISCUSSION

Results on samples damaged by abrasion. It is well established that abrasion of potato granules leads to an increase in rubberiness. Therefore, by varying the mechanical damage to a sample, the texture could be proportionately varied for study. A sample of commercial potato granules was damaged by grinding 200-g. portions for 2 and 3 minutes at high speed in a food blender. These were combined in proportions that would produce granules with a Blue Value Index of about 300 units *(5)*. This was arbitrarily called the 100% damaged sample, but, of course, the number of damaged cells was not known. This sample was mixed with the original undamaged product in varying ratios so that samples having 6 different texture grades were available for testing.

Diameters of the cakes formed were determined as described above. Blue Value Indexes were also determined. Portions of these potato granule samples were reconstituted manually for sensory evaluation for texture by a trained panel of 11 judges. For this appraisal, the reconstitution ratio was 4.5 to 1, calculated as stated. The granules were added to the water at 180°F. in 10 seconds while stirring 20 strokes with a fork and mixing continued for a total of 30 seconds with 60 strokes. The beakers were covered without leveling the surface and allowed to stand 15 to 45 minutes at room temperature before judging. The samples were coded and presented without controls. Each set was judged for consistency 4 times on different days, and ranked on a scale of rubberiness of the mashed potatoes, as described by Wood *et al. (9)*.

Individual ranks were used in the analyses of variance. Sources of variation were treatment, treatment-by-judge interaction, and treatment-by-replicate interaction and remainder. Neither of the interactions was significant. The Duncan shortest significant range values *(2)* for adjoining means at probability of 0.05 were calculated and all adjoining pairs were found to be significant by this criterion, Table I.

It is evident (Table 1) that, as the texture became more rubbery, with increased damaged material in the

TABLE 1

Consistency factors of potato granules after various degrees of mechanical damage

Damaged[1]	Blue Value index	Texture rank[2]	Cake diameter	
			Mean	Maximum deviation
%			mm.	%
0	115	1.3	66.4	1.1
10	135	2.1	61.9	0.6
20	153	2.8	61.0	0.8
33	182	3.9	58.4	1.2
67	255	5.1	53.8	1.9
100	311	5.6	51.0	1.4

[1] Sample having zero damage = original.
[2] Rank 1 = not rubbery; 6 = rubbery; S.S.R. (Duncan) at P = 0.05 = 0.38.

sample, as was to be expected from previous work *(5)*, the cake diameter decreased due to the increased pastiness or cohesive nature of the mashed potato.

Results with various commercial samples. A comparison was made of results from sensory appraisal and cake-diameter measurements of 6 lots of potato granules from industrial and experimental production. The purpose was to establish the correlation for granules having a substantial range in consistency and where texture differences could be due to variables in the manufacturing processes that did not necessarily affect the Blue Value Index. The granules were of good, medium, and fair texture, based on preliminary diameter measurements. Moisture contents ranged from 6.3 to 10.8% but are not tabulated as amounts of water used were adjusted as stated in the procedure. Results are shown in Table 2. This comparison of the results (Table 2) by the

TABLE 2

Comparison of sensory and objective results for consistency of commercial samples

Sample No.	Blue Value Index	Texture rank[1]	Cake diameter		Standard error
			Mean	Maximum deviation[2]	
			mm.	%	
1	35	1.1	71.4	0.7	0.23
2[3]	133	2.5	65.5	2.3	0.78
3[3]	139	2.8	60.8	0.7	0.20
4	77	3.9	58.3	0.2	0.07
5	103	4.8	56.0	0.7	0.23
6	149	5.9	52.7	2.3	0.67

[1] Textural rank 1 = least rubbery; 6 = most rubbery; S.S.R. (Duncan) at P = 0.05 = 0.31.

[2] Example: Diameter in triplicate (71.2-71.2-71.9 =)71.4; 0.5/71.4 = 0.7%.

[3] Sample No. 2 contained 10% damaged material; No. 3 was produced in the pilot plant of this laboratory.

2 methods of estimating texture shows a good correlation of panel appraisal rank with cake diameter for all the samples, but, as expected, no correlation with Blue Value Index due to diverse unknown factors, in addition to soluble starch, which were shown to affect consistency *(5)*. The mean diameters of the cakes decreased with increasing rubberiness of the samples as designated by the larger rank numbers.

When an absolute value for texture of potato granules is to be determined by sensory evaluation, controls or reference samples must be included for comparison. If the samples to be compared are tested at different times, stability of the controls during storage must be assured (9). Small changes in cake diameter of some samples (Table 2) were observed during storage at room temperature. Five of them increased approximately 1 to 7% in diameter in 7 months and one was essentially unchanged. However, a portion of the sample that changed 7% at room temperature was practically unchanged in cake diameter after 16 months at 34°F. Results similar to those for small changes in texture factors at room temperature were indicated in previous reports *(5, 9)*. Further, rank numbers will change with number of samples appraised in a set, while diameters of course do not. The cake diameter determination is useful in resolving these difficulties in that reference samples are not needed.

SUMMARY AND CONCLUSIONS

When a ball of rehydrated potato granules was allowed to fall upon a smooth surface, the diameter of the resultant cake was found to be related to consistency or rubberiness as determined by a panel of trained judges. Reconstituted experimental and commercial samples of granules showed a high degree of correlation between cake diameter and sensory ratings for rubberiness over a substantial range in consistency, which was essentially independent of the soluble starch content. Diameter tests on samples of potato granules mechanically damaged by abrasion to lower the texture quality by release of free starch also were correlated with texture determined by the panel and with the Blue Value Index for soluble starch.

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Stability of Frozen Concentrated Orange Juice

IV. Effect of Heat Treatment on Hamlin, Pineapple, and Valencia Juices at Different Stages of Maturity [a, b]

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PREVIOUS REPORTS in this series have discussed : (a) effect of various times and temperatures of heat treatment on enzyme inactivation and cloud stability *(3)*, (b) effects of several methods of heat stabilization *(4)*, and (c) effect of heat treatment in the production of high-brix frozen concentrates *(2)*. In the present work the effect of variety and maturity on heat treatment required for stabilization of frozen orange concentrates will be discussed.

Rouse *(6)* reported a 25% separation in unpasteurized Hamlin and Valencia concentrates after 30-day storage at 40° F. Hamlin products showed a semigel and Valencia a slight gel. Moore, Huggart, and Hill *(5)* observed unpasteurized Hamlin, Pineapple, and Valencia concentrates after one week in 40° F. storage. Clarification was definite in Valencia and extreme in Hamlin and Pineapple products. At this storage temperature, Hamlin and Valencia concentrates showed a slight gel after 2 months and Pineapple a semigel after 2 weeks. Wenzel, Moore, Rouse, and Atkins *(10)* observed no gelation in unpasteurized Hamlin concentrate after one month at 40° F., while Pineapple products showed a semigel and Valencia a very slight gel. Definite clarification was observed in Hamlin products after one month at 10° F. and in Pineapple and Valencia concentrates after 3 months at 20° F. Rouse and Atkins observed that holding for 15 seconds at 195° F. resulted in complete pectinesterase (PE) inactivation in Hamlin and Pineapple orange juices of pH 3.8 in one study *(8)*, and in Valencia juice of pH 4.1 in another study *(7)*. In these studies at 200° F. a holding time of 5 seconds for Hamlin, 3 seconds for Pineapple, and 5 seconds for Valencia orange juice also gave complete PE inactivation. Again, Atkins and Rouse *(1)* found that after adjusting Pineapple and Valencia orange juices to pH 3.5 complete inactivation of PE occurred with a 3-second treatment at 200° F. or 12 seconds at 190° F.

Rouse and Atkins *(9)* prepared unpasteurized Pineapple orange concentrates at monthly intervals from December to April and observed for stability after 24 hours at 80° F. In all products clarification was extreme and the consistency that of a semigel.

This investigation was undertaken to determine the heat treatment required to stabilize the cloud in concentrates prepared from oranges of different varieties and maturities. The effects of heat treatments on enzyme activity and flavor of frozen orange concentrates were also observed.

EXPERIMENTAL

Representative sections of groves of Hamlin, Pineapple, and Valencia varieties were chosen. For each variety 20 trees were selected and one box was obtained from a different sector of each tree at each picking. Because of the short Hamlin processing season, samplings were made at weekly intervals. Pineapple and Valencia oranges, however, were sampled at 2-week intervals. The fruit was picked, stored at 40° F., and used the following day. Oranges were washed and the juice extracted with a Rotary Juice Press.[c] The juice was finished with an 0.033-in. screen and held at 40° F. in a cold wall tank until used. It was heated in a tubular pasteurizer for 0.8 seconds, held for 5 seconds, and cooled with ice water to 90° F. or below in 3 seconds. The juice was concentrated to 55° Brix in a falling film evaporator at 75° F. and cut back to 42° Brix with unheated juice. The equipment and methods followed were described in detail previously *(2)*. Methods used in estimating PE activity and visiual and colorimetric cloud stability were described in the same publication.

For estimation of cloud stability, concentrates were placed in 40° F. storage and examined at frequent intervals over a period of 6 weeks. Colorimetric determinations of residual cloud were made immediately upon reconstitution, whereas, for visual estimation, the reconstituted juices were held for 24 hours at 40° F., then graded as *stable*, *partially separated*, or *completely separated*. By using both colorimetric and visual methods, it was possible to correlate ranges of light transmission with the visual grades. The reconstituted 42° Brix concentrates were tested for flavor differences by a taste panel composed of 16 to 20 persons who had been selected for their ability to detect small flavor differences. A hedonic preference rating scale of 1 to 9 was used in which 5 indicates neither a *like* nor *dislike*. Each variable was tested 4 times, 2 times each against samples processed on the same date and from the same lot of oranges, but which had received heat treatments at other temperatures; and 2 times against products heated at the same temperatures, but processed on different dates.

[a] A partial report on work conducted at the U. S. Citrus Products Station, Winter Haven, Florida, under a Memorandum of Understanding between the Continental Can Company, Inc., New York, New York, and the Southern Utilization Research and Development Div., Agricultural Research Service, U. S. Department of Agriculture.

[b] Presented at the 17th Annual Meeting of the Institute of Food Technologists, Pittsburgh, Pennsylvania, May 15, 1957.

[c] Mention of trade products does not imply endorsement over similar products not mentioned.

RESULTS AND DISCUSSION

With Hamlin fruit no important differences were observed in ° Brix, titratable acidity, pH, peel oil, or suspended solids, as shown in Table 1. Probably the short harvesting season (20 days) was a factor. Both the Pineapple and Valencia varieties showed substantial decreases in acidity with advancing maturity. This usually was accompanied by a rise in pH and an increase in soluble solids. Variations in peel oil content were probably due to fruit condition as influenced by rainfall or irrigation rather than maturity or variety. Suspended solids were generally higher in the early and midseason varieties.

TABLE 1

Composition of fresh juices used in preparing experimental packs

Date packed	Soluble solids	Acid[1]	pH	Oil	Suspended solids
	°*Brix*	%		%	%
Hamlin variety second season					
12/10/53	10.08	.74	3.8	0.020	12.0
12/17/53	10.41	.77	3.8	0.012	12.3
12/23/53	10.74	.72	3.8	0.020	13.0
12/30/53	10.51	.69	3.8	0.014	13.0
Pineapple variety first season					
1/21/53	12.7	1.05	3.8	0.035	13.5
2/2/53	12.2	.97	3.8	0.030	13.0
2/16/53	13.0	.85	3.9	0.030	12.0
3/3/53	12.9	.82	3.8	0.030	14.0
Pineapple variety second season					
1/7/54	11.9	.89	3.8	0.06	13.5
1/21/54	12.2	.86	3.8	0.05	12.8
2/4/54	12.7	.89	3.7	0.04	14.0
2/18/54	13.6	.83	3.8	0.04	14.5
3/4/54	13.2	.84	3.9	0.03	14.0
3/18/54	13.7	.77	4.0	0.04	13.0
Valencia variety first season					
4/14/53	12.2	.99	3.7	0.030	9.5
4/28/53	11.8	.98	3.7	0.020	11.0
5/12/53	12.2	.96	3.6	0.032	11.0
5/27/53	12.0	.79	3.9	0.040	11.0
6/12/53	11.7	.71	3.9	0.050	—
6/23/53	11.4	.64	4.0	0.072	10.5
Valencia variety second season					
2/11/54	10.6	1.13	3.6	0.090	9.5
2/25/54	10.8	1.09	3.5	0.070	9.5
3/11/54	11.0	1.08	3.6	0.100	8.8
3/26/54	11.0	.94	3.6	0.080	8.5
4/8/54	11.2	.87	3.6	0.070	9.0
4/22/54	11.4	.88	3.6	0.070	10.0
5/5/54	11.7	.80	3.7	0.080	9.0
5/20/54	11.6	.75	3.7	0.060	10.0
6/3/54	11.8	.76	3.9	0.080	10.0

[1]As anhydrous citric acid.

No marked effects on maturity on PE within the varieties were noted as shown in Table 2. There were some variations between seasons and among varieties but the data are insufficient to establish trends. More PE remained with advancing maturity when heat treatments of 140°, 150°, and 160° F. were used. Similar differences were not observed with 170° and 180° F. treatments except in Valencia products of the second season.

Visual cloud stability data in Table 2 show that Hamlin orange concentrates were least stable and Valencia concentrates most stable. Heat treatment was more effective in stabilizing the cloud in Valencia products than in the other varieties. Concentrates prepared from Hamlin juice heated at 170° F. were stable for one week according to the visual test. Pineapple concentrates prepared from juice heated at this temperature were stable for 2 to 3 weeks while Valencia concentrates were stable for 4 to 6 weeks. Advances in maturity were accompanied by only minor differences in visual cloud stability.

Cloud stability curves for the products when stored at 40° F. are given in Figure 1. In comparing the visual cloud stability data with light transmission data obtained with the colorimeter, it was found that no visual separation was apparent when light transmission values were below 38% and complete separation was observed when the light transmission values were above about 75%. Intermediate values generally indicated partial separation. On the basis of this comparison, each graph has been divided into 3 zones designated as *stable, partially separated,* and *completely separated.*

The upper portion of Figure 1 presents curves of averaged data from 4 packs of Hamlin, 6 packs of Pineapple, and 9 packs of Valencia orange concentrates. It is shown that cloud was retained in concentrates of Valencia orange juice for longer periods than in those made from either Hamlin or Pineapple juice. In turn, in concentrates made from Pineapple juice the cloud remained stable somewhat longer than in those from Hamlin juice. This varietal difference was evident among unheated controls as well as among concentrates receiving similar heat treatments. It is further observed that Valencia products heated at 160° F. had a greater cloud stability than either Hamlin or Pineapple products heated at 180° F.

Although 4 packs of Hamlin orange concentrate were prepared, the harvest period encompassed less than one month. No change in cloud stability was demonstrated in the data for this short period; therefore, detailed data are not presented.

Data on the effect of maturity of Pineapple oranges presented in the middle of Figure 1 are the averaged results of two processing periods in each of the 3 months indicated; *i.e.,* January, February, and March. No effect of maturity could be shown for controls or concentrates of juices heated at 150° F. The cloud in concentrates prepared in February and March having heat treatments of 160° to 180° F. was somewhat more stable than in similar concentrates processed in January.

In the lower portion of Figure 1 each graph represents the averages of 3 separate packs of Valencia orange concentrate within the periods indicated, with results somewhat variable. Among controls, cloud stability was greatest in the late March and April packs. Among 150° and 160° F. heat-treated packs, those prepared in February and March showed the most cloud stability. Among 170° F. packs, those prepared in May and early June were most stable. All packs prepared from juice heated to 180° F. were quite stable. Differences in cloud stability resulting from differences in time of harvest were less than the differences between the 3 varieties.

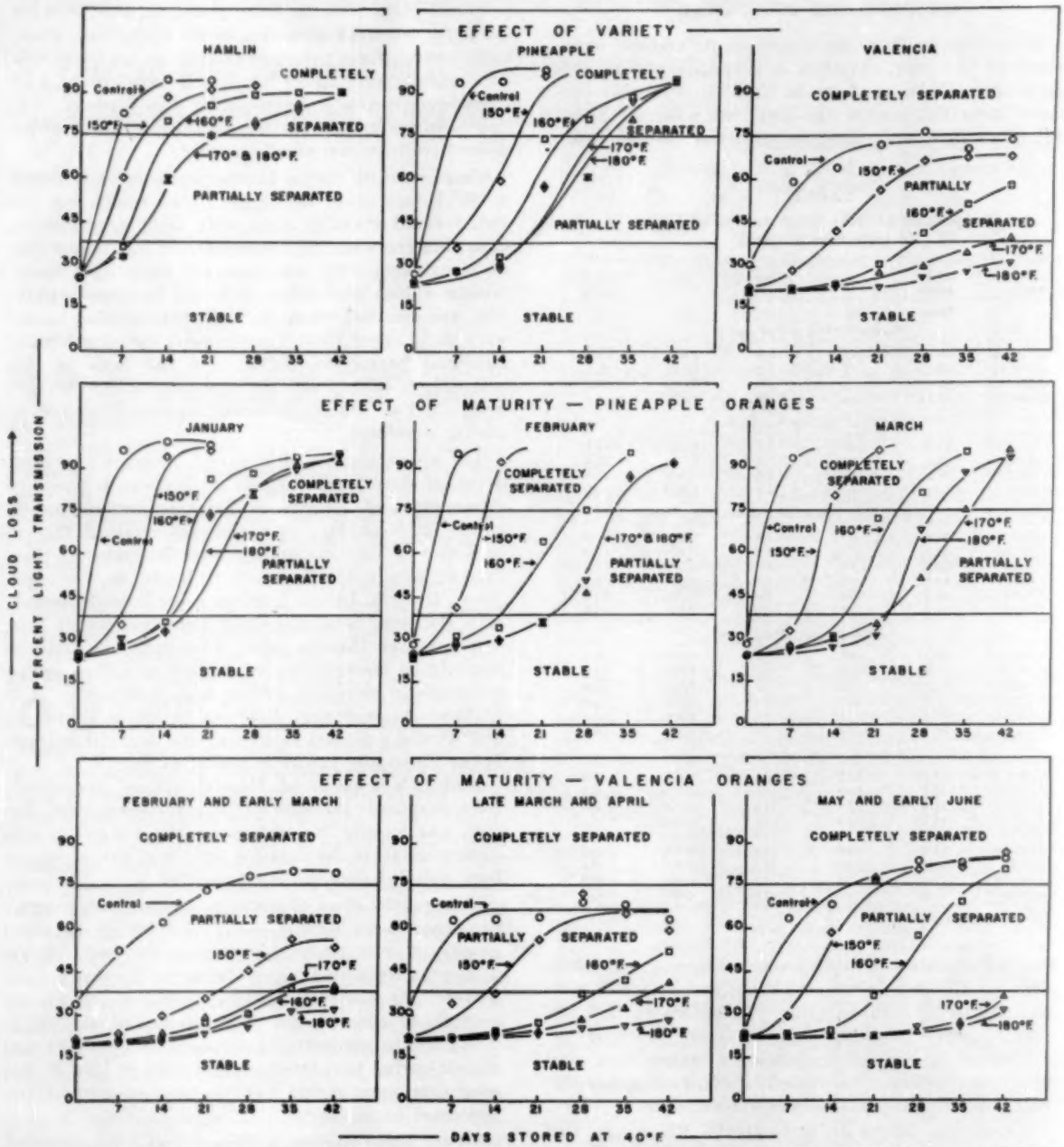

Figure 1. Effect of variety and maturity on cloud stability of concentrates prepared from heated and unheated orange juices.

In flavor tests of Hamlin orange products, the concentrate packed on December 30 was graded somewhat lower than that packed on the earlier dates. Most panel members rated this juice as flat and very low in flavor. No significant difference was noted between heat-treated products and controls.

No effect of heat treatment on flavor was shown among Pineapple concentrates packed in January or February. However, in the last two packs (March 4 and 18) panel members detected a significant difference between the 170° and 180° F. heat-treated samples and the unheated controls. This was more noticeable in concentrates processed on March 18 than those processed on March 4.

No significant differences in flavor were observed between control and heat-treated Valencia products. There was a slight preference for the flavor of concentrates packed in the latter part of the processing period for this variety. Samples packed in February and March were very sharp due to the high acid content which would account for their being graded somewhat lower than the less acid later production.

TABLE 2

Pectinesterase activity and visual cloud stability in 42° Brix concentrates

Date packed	Enzyme activity							Cloud stability at 40° F						
	Control	140°F	150°F	160°F	170°F	180°F	200°F	Control	140°F	150°F	160°F	170°F	180°F	200°F
	PEu./ml. x 10^4 per 12° Brix							*Weeks*						
Hamlin variety second season														
12/10/53	18.1	—	12.3	3.8	3.2	3.2	—	0	—	0	1	1	1	—
12/17/53	18.0	—	9.4	7.0	3.0	2.7	—	0	—	0	0	1	1	—
12/23/53	15.0	—	11.3	6.5	4.0	2.9	—	0	—	0	1	1	1	—
12/30/53	16.6	—	13.3	8.5	3.8	2.5	—	0	—	0	1	1	1	—
Pineapple variety first season														
1/21/53	19.1	—	—	3.7	—	3.4	1.9	0	—	—	1	3	—	6
2/2/53	18.9	—	—	5.0	—	2.8	2.1	0	—	—	2	2	—	6
2/16/53	22.3	—	—	6.3	—	3.4	2.0	0	—	—	2	2	—	6
3/3/53	21.1	—	—	6.1	—	3.0	3.5	0	—	—	1	2	—	6
Pineapple variety second season														
1/7/54	23.4	—	12.4	6.6	4.1	3.4	—	0	—	1	1	2	2	—
1/21/54	27.8	—	15.1	8.3	4.1	3.4	—	0	—	1	2	2	2	—
2/4/54	24.5	—	13.2	6.4	4.1	3.6	—	0	—	1	2	2	2	—
2/18/54	26.1	—	18.0	9.8	4.8	3.5	—	0	—	0	2	3	3	—
3/4/54	25.9	—	16.7	8.8	5.0	3.5	—	0	—	1	2	3	3	—
3/18/54	23.7	—	16.3	8.9	4.8	3.5	—	0	—	1	2	3	3	—
Valencia varsity first season														
4/14/53	20.5	14.9	—	4.9	—	3.0	1.5	0	1	—	4	—	5	6
4/28/53	22.1	20.5	—	4.9	—	4.6	1.4	0	0	—	3	—	6	6
5/12/53	23.1	18.0	—	5.4	—	3.6	1.7	0	0	—	2	—	6	6
5/27/53	22.0	19.3	—	9.8	—	3.6	2.0	0	0	—	3	—	6	6
6/12/53	22.5	20.0	—	12.1	—	3.3	1.6	0	1	—	3	—	6	6
6/23/53	20.0	21.3	—	14.4	—	3.0	1.9	0	1	—	3	—	6	6
Valencia variety second season														
2/11/54	18.5	—	4.7	3.4	2.2	2.1	—	0	—	3	4	4	6	—
2/25/54	20.3	—	3.8	3.0	2.7	2.1	—	0	—	3	4	4	6	—
3/11/54	13.7	—	6.4	3.2	2.5	2.4	—	0	—	3	6	6	6	—
3/26/54	20.2	—	7.9	3.6	2.9	2.5	—	0	—	2	5	6	6	—
4/8/54	23.5	—	11.7	4.0	2.8	2.3	—	0	—	1	3	5	6	—
4/22/54	16.6	—	12.5	5.0	2.2	3.0	—	0	—	2	3	5	6	—
5/5/54	16.5	—	14.1	6.3	3.5	3.3	—	0	—	1	3	6	6	—
5/20/54	19.1	—	11.3	8.6	4.6	4.7	—	0	—	1	3	5	6	—
6/3/54	19.6	—	16.6	8.2	4.2	3.7	—	0	—	1	2	6	6	—

SUMMARY

Concentrates from heat-treated Hamlin, Pineapple and Valencia orange juices were examined for PE activity, cloud stability, and flavor.

With each variety tested, heat treatments at 150° and 160° F. inactivated a lesser percentage of the enzyme with advancing maturity. There was little effect of maturity on the percentage of enzyme inactivation for the juices heated at 170° and 180° F.

Cloud stability was greatest in both heated and unheated juices of the Valencia variety and least in that of the Hamlin. Cloud stability was attained for Valencia concentrates at lower heat treatment temperatures than for the other two varieties. Differences in cloud stability resulting from differences in time of harvest were less than the differences between the three varieties.

No effect of heat treatment on flavor of the products was observed in the Hamlin or Valencia concentrates; however, a significant difference was observed in the Pineapple products packed in March which had received heat treatments of 170° and 180° F. The Hamlin concentrates packed in late December were flat and low in flavor while Valencia products processed in May and June were superior to those of earlier packs.

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Stability of Frozen Concentrated Orange Juice.

V. The Effect of Heat Treatment at Intermediate Stages of Concentration on Juices Prepared from Valencia Oranges[a, b]

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In this series of papers dealing with a comprehensive study of the various aspects of heat stabilization of frozen concentrated orange juice, previous contributions have dealt with the effects of different times and temperatures of heat treatment on enzyme inactivation and cloud stability of frozen Pineapple and Valencia orange concentrates *(6)*, comparison of a small tube heat exchanger, plate type pasteurizer, and a steam injection heater for enzyme inactivation and improving cloud stability *(7)*, effect of heat treatments in the production of high-Brix frozen concentrate *(3)*, and the effects of seasonal and varietal factors on cloud stability, enzyme activity, and flavor *(4)*. The current study, fifth in the series, deals with a three-year investigation of the effect of heat treatment at several stages of concentration on cloud stability, flavor, and pectinesterase activity of frozen concentrated orange juice made from Valencia oranges.

An investigation reported by Bissett, Veldhuis, and Rushing *(2)* indicated that the cloud stability of hot pack, 6-fold concentrate was enhanced by heat treatment when compared with products treated at lower concentrations. Stability of 6-fold concentrate was achieved at treatment temperatures of 160°F. or higher, while less concentrated products required a treatment temperature of 190°F. for stability. Keller, Rice, McColloch, and Beavens *(8)* in studying the effects of heating single strength, 27°, 43°, and 58° Brix products, found that heat treatment of the higher concentrations brought about a greater inactivation of pectinesterase than heat treatment of single strength juice, although it was not clear-cut from the results that heating at a particular concentration will cause a greater inactivation of pectinesterase than any other, excepting that heating any of the higher concentrations brings about a greater inactivation of pectinesterase than in single strength juice. Results of investigation by Keller *et al. (8)* also indicated a concentration effect on cloud stability; that is, the higher the concentration at which the juice was heated, the greater the increase in cloud stability. They also reported that as the concentration increased, there was a tendency toward flavor change as a result of heat treatment. In contrast, Atkins and Rouse *(1)* reported that when 1-, 2-, 3-, and 4-fold Valencia juices were heated to temperatures of 125° F. to 155° F. there was a tendency toward greater inactivation of the enzyme at the lower concentrations. At higher temperatures, little if any difference in enzyme inactivation was noted between the various degrees concentration at which heat treatment was effected. DuBois and Murdock *(5)* found that stabilization of Pineapple and Valencia concentrates could be effected by heating at 150°F. for approxmiately 10 seconds between stages of concentration at 18° Brix.

Studies reported here were designed to supplement the above information on pectinesterase inactivation and cloud stability by determining the effectiveness of heat treatments at commercially applicable intermediate stages of concentration.

PROCEDURE

For the purpose of this investigation, an adequate number of boxes of Valencia fruit were obtained and stored at 40°F. until used. In the first two seasons' work, sufficient fruit for a day's operation was removed from storage in a random manner, washed, and the juice extracted in a Rotary Juice Press[c]. Rag and seed were removed by passing through a finisher equipped with an 0.033" screen. All the juice for a day's run was extracted in early morning and pumped directly to a coldwall tank and held at 40°F. until required for processing. In the third season's work the fruit was completely randomized on a special piece of equipment, designed for this purpose, before storage at 40° F. Juice was extracted on a Brown Citrus Machinery Corporation extractor[c] and juice sufficient for an individual temperature-concentration variable only was extracted at one time. The finisher was modified from that of a fixed position to an air-loaded screw operated at seven pounds gage. These changes produced experimental juice more nearly representative of that produced commercially.

In addition to applying several heat treatment temperatures to the single strength juice before concentrating, portions were

[a] A partial report on work conducted at the U. S. Citrus Products Station, Winter Haven, Florida, under a Memorandum of Understanding between the Continental Can Company, Inc., New York, N. Y., and the Southern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

[b] Presented at the Seventeenth Annual Meeting of the Institute of Food Technologists, Pittsburgh, Pennsylvania, May 15, 1957.

[c] Mention of trade products does not imply endorsement over similar products not mentioned.

also partially concentrated, heat treated, and then returned to the evaporator to complete concentration. In each case, heat-treated materials as well as unheated controls were concentrated to 55° Brix, cut back to 42° Brix with unheated juice, canned, and frozen under air blast at 0°F.

Slight variations were made in the concentrations at which heat treatment was applied and in the temperatures used over the 3-year study period. In the first season's study, controls were packed and heat treatments of 140°, 160°, 180° and 200°F. using a 5-second hold time were applied to concentrations of 12°, 22°, 42° and 55° Brix. Based on initial results from this study, for the second and third seasons' studies heat treatments were changed to 150°, 160°, 170° and 180°, with a 5-second hold time and were applied to single-strength juice and concentrates of 20°, 26°, 32° and 38° Brix. The heat stabilization treatment was applied in a small tube turbulent flow heat exchanger and the concentration was accomplished in a falling film pilot plant evaporator described previously *(7)*.

Methods used in estimating pectinesterase activity and colorimetric and visual cloud stability were also described in the same publication *(7)*. The reconstituted 42° Brix concentrates were tested for flavor differences by a taste panel composed of 16 to 20 trained panel members. A hedonic preference rating scale of 1 to 9 was used where 5 indicates *neither like nor dislike*, where 1 indicates an extreme dislike, and 9 an extreme liking for the product. Each sample was tested 4 times: twice against samples heat treated at the same temperature but at different concentrations, and twice against samples heat treated at the same concentration at different temperatures.

Average analyses of juices used in these investigations are presented in Table 1.

TABLE 1

Average analyses of Valencia orange juices used in these studies

Season	Brix	Anhydrous Citric Acid	pH	Suspended Solids	Oil Content
1953	12.0°	1.06%	3.67	10.6%	0.020%
1954	11.3°	0.90%	3.60	11.0%	0.040%
1956	11.4°	0.85%	3.85	13.5%	0.033%

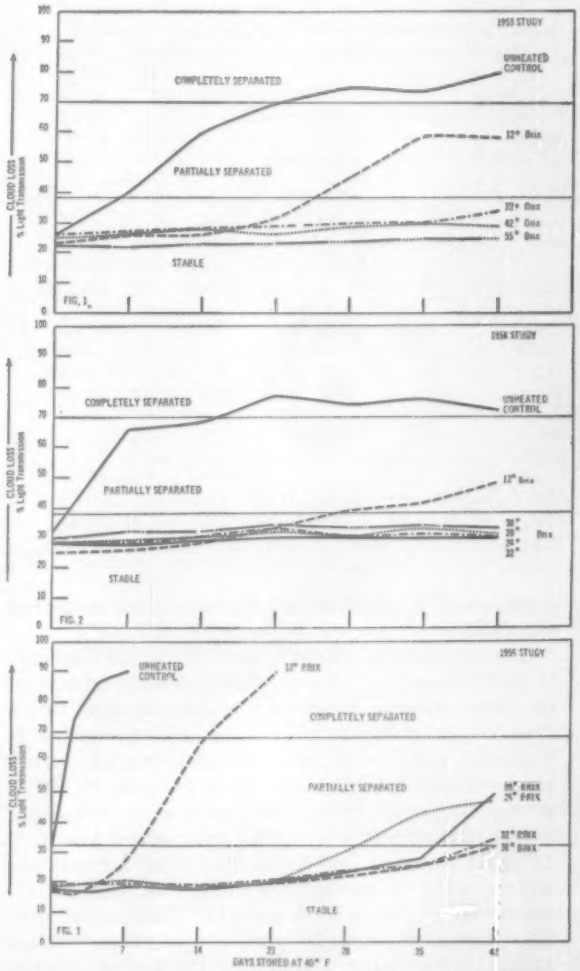
RESULTS AND DISCUSSION

Enzyme inactivation. Results of heat stabilizing treatments at various stages of concentration on the pectinesterase activity in frozen concentrate made from Valencia oranges are summarized in Table 2. Determinations were made on single strength juice or concentrate reconstituted to 12° Brix, and results reported as percent inactivation based on unheated, single strength juice as the standard. These data show the effect of the various temperature-concentration treatments on enzyme activity in the intermediate concentrate, 55° Brix concentrate, and 42° Brix final product. Cloud stability of 42° Brix products stored at 40°F. is also presented in Table 2.

Results obtained in 1953 with a 140°F. heat treatment for 5 seconds at the several concentrations were erratic, and this treatment temperature was comparatively ineffective in reducing the enzyme activity. Although the 150°F. treatment used in the 1954 and 1956 seasons was more effective in reducing the enzyme activity, the results were also somewhat erratic. In the 1956 study, heat treatments at 150°F. and 160°F. were more effective in reducing the activity at the intermediate concentrations than in single strength juice. With this exception, no significant differences were observed in the effect of any specific heat treatment at the different concentrations.

During the course of these investigations changes took place in commercial extraction and finishing procedures. Therefore, as previously outlined, changes were made in the pilot plant extracting and finishing equipment before the third season's investigation. These changes were made so that experimental juices would be more nearly respresentative of commercial operations. In this work a sharp increase in pectinesterase activity in unheated controls was noted. Treatment at 150° F. was less effective in inactivation of the enzyme than in previous work; whereas, the results of treatments at higher temperatures were comparable.

Cloud stability. For ease of presentation, the 160°F. series was chosen to show effect of heat treatment at various stages of intermediate concentration. (Figures 1, 2, 3, and Table 2.) Previous studies *(6)* have shown that heat treatment at 140°F. and 150°F. materially increased cloud stability but not to the



Figures 1, 2 and 3. Stabilizing effect of a 160° heat treatment at various stages of concentration.

TABLE 2

Comparison of effect of heat treatment at several stages of concentration on pectinesterase activity and cloud stability in Valencia orange juice concentrate

	Treatment Temp.	Treatment Brix	Percent Inactivation			Days 42° Brix Conc. Stable at 40° F.
			Intermediate Conc.	55° Brix Conc.	42° Brix Conc.	
1953 Study	140° F	12°	2	20	25	7
		22°	34	49	42	18
		42°	23	36	21	10
Controls stable for an average of 4 days at 40° F.		55°	13	—	8	9
	160° F	12°	78	84	76	24
		22°	89	89	83	42
		42°	90	92	84	42
		55°	90	—	82	42
	180° F	12°	88	90	80	35
		22°	87	88	78	42
		42°	89	92	86	42
		55°	90	—	84	42
	200° F	12°	99	99	93	42
		22°	98	97	92	42
		42°	97	97	92	42
		55°	97	—	91	42
1954 Study	150° F	12°	62	67	50	10
		20°	70	76	70	42
Controls stable for 2 days at 40° F.		26°	81	85	79	42
		32°	86	85	76	42
		38°	79	71	73	28
	160° F	12°	89	89	78	26
		20°	90	88	82	42
		26°	91	92	86	42
		32°	93	91	84	42
		38°	92	90	86	42
	170° F	12°	94	90	86	42
		20°	93	90	82	42
		26°	91	93	86	42
		32°	90	92	85	42
		38°	93	89	83	42
	180° F	12°	95	94	83	42
		20°	93	90	84	42
		26°	91	92	86	42
		32°	90	91	86	42
		38°	93	89	84	42
1956 Study	150° F	12°	58	18	17	4
		20°	55	51	38	12
Controls completely separated at initial examination.		26°	67	61	62	20
		32°	52	55	60	27
		38°	60	48	51	13
	160° F	12°	79	58	47	8
		20°	82	84	74	36
		26°	90	88	84	29
		32°	89	90	85	40
		38°	90	91	84	42
	170° F	12°	91	82	77	11
		20°	94	92	85	23
		26°	95	94	89	27
		32°	93	92	86	35
		38°	92	93	87	38
	180° F	12°	96	91	87	8
		20°	94	93	87	25
		26°	95	94	89	20
		32°	92	93	88	29
		38°	93	93	86	26

point where it could be considered commercially acceptable.

Heat treatments of 160°F. and 180°F. for 5 seconds in the 1953 study (Table 2) show a definite advantage for heat treating intermediate concentrates rather than single strength juice. The data presented in Figures 1 and 2 show that although unheated controls were completely separated after 3 weeks in 40°F. storage, all heat treated products were completely stable. Concentrates prepared from juices heated at 12° Brix began to lose their cloud after 3 weeks and were graded as partially separated throughout the remainder of the six-week period of observation. Products heated as partially concentrated juices retained their cloud stability throughout the 6-week observation period. Heat treatments at higher temperatures during these two seasons rendered all products stable during the full observation period, regardless of concentrations at which heat treatments were effected.

Orange juice processed in 1956 was less stable than that of the 1953 and 1954 season (Figure 3) as shown by the rapid loss of cloud in the unheated control. The product of juice heated at 12° Brix retained a good cloud for only one week. Products of heat treatment at intermediate concentrations remained stable for 3 weeks after which some cloud loss occurred. Treatment at 170° and 180° F. produced cloud stabilities quite similar to, although for slightly shorter periods than, that of the 160°F. treatment.

During the 1956 season, an investigation was undertaken to determine the effect of heat treatment at intermediate stages of concentration on juice prepared

from Hamlin and Pineapple varieties. During the course of these studies, sufficient juice was extracted at one time for a whole day's run or at least for several temperature-concentration variables, and held at 40°F. until used. When cloud stability studies were conducted on samples so produced, it was noted that the combined holding period as single strength juice and in the evaporator at 75°F. prior to heat treatment resulted in erratic cloud stability data—which emphasize the importance of rapid heat treatment and proper handling of extracted juices. Extended holding periods prior to stabilization should be avoided if satisfactory cloud stability is to be attained in concentrates of these two varieties.

Flavor. All products from the 1953 and 1954 studies when evaluated showed no significant differences in flavor. When products from the 1956 studies were evaluated, no significant flavor differences were detected where a given temperature was applied to juices of different concentrations. However, there was a difference, which was significant at the 1% level, between controls and products heat treated at 180°F. although no objectionable flavors were noted. The results of the series of tests comparing temperature variables are shown in Table 3.

Statistical analysis showed that there is an indication (P=95%) of an interaction betwen the degree Brix and the temperature at which heat treatment was effected.

TABLE 3

The effect of various heat treatments at intermediate stages of concentration on the flavor of frozen concentrate made from Valencia oranges, 1956 study[1]

Concentration Variable	TREATMENT TEMPERATURE				
	Unheated	150° F.	160° F.	170° F.	180° F.
12° Brix	6.3	6.6	6.6	6.1	5.7
20° Brix	7.1	6.7	6.6	5.7	5.9
26° Brix	6.3	6.4	6.4	6.6	5.6
32° Brix	7.2	6.3	6.3	6.2	5.9
38° Brix	6.8	5.9	5.0	6.5	6.2
Average	6.7	6.4	6.2	6.2	5.9

[1] Hedonic preference scale of 1-9: 5 = *neither like nor dislike;* 1 = *extreme dislike;* 9 = *extreme liking.*

SUMMARY

An investigation was undertaken over a 3-year period to study the effect of heat treatment at intermediate stages of concentration on the cloud stability, enzyme inactivation, and flavor of frozen concentrate prepared from Valencia oranges.

Heat treatment of intermediate concentrates generally resulted in better cloud stability than heat treatment of the single strength evaporator feed juice. Although not demonstrated in all 3 seasons, there were indications that enzyme inactivation was greater when heat treatments were applied to intermediate concentrates than when applied to single strength juice. A significantly different, but not objectionable, flavor was found in products heated at 180°F. in the third season's investigation. In the first and second season's study, no flavor differences were observed.

Qualitative observations indicated that appreciable time delays prior to heat stabilization, either during evaporator feed storage or partial concentration, are undesirable from a cloud stability standpoint.

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Factors Affecting Quality of Prepackaged Meat[a]

II. Color Studies. A. Effect of Package Characteristics Upon Color of Product[b, c]

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SINCE COLOR IS PROBABLY the first of the quality criteria by which the consumer is influenced in selecting meat, discoloration is a most important aspect of the shelf life of prepackaged meat. Seventy-five out of 97 stores surveyed by the Production and Marketing Administration *(1)* considered discoloration to be a major problem. Most store operators reported a maximum shelf life of from 48 to 72 hours, the majority giving 48 hours as the limit.

The present study will deal primarily with color changes in meat which are produced by changes in various influencing conditions having to do with storage. Effects of different variables upon the color of the meat will be reported. The variables studied were: (1) package types[d], (2) temperature, (3) vacuum, (4) composition of atmospheres, (5) antioxidants, (6) inoculation with *Achromobacter sp.*, (7) light vs. dark storage, and (8) fat. A Hunter Color and Color-Difference Meter was used to measure the change in redness of the meat.

For the purpose of developing a simplified spectrophotometric method of estimating the proportions of the 3 principal modifications of the heme pigments in fresh meat—namely, oxymyoglobin, metmyoglobin, and reduced myoglobin—a collateral study was undertaken. A report on this method will be published separately from this series, however, since it is not within the scope of the present paper.

[a] A report of work conducted by contract with the Bureau of Animal Industry, U. S. Department of Agriculture, with funds provided under the Research and Marketing Act.

[b] A paper of the Journal Series, N. J. Agricultural Experiment Station, Rutgers University, the State University of New Jersey, Departments of Food Technology and Animal Husbandry, New Brunswick, N. J.

[c] Part II of this series is divided into 4 sections, of which this paper constitutes the first. Section IIB is concerned with effects of storage time, storage temperature, antioxidants, bacteria, light, freezing, and fat upon color of product and will appear in a subsequent issue.

[d] To assist the reader, the following legend of codes representing the various package types used in this investigation, will be repeated. They are:

Code No.	*Packaging Material*
2	Can
3	Unpackaged
4a	Vinylidene copolymer (Cry-O-Vac)
6	MSAT86 cellophane, coated both sides
6a	MSAT80 cellophane, coated side inside
6d (1)	MSAT80 cellophane, coated side outside
6w (1)	MSAT80 cellophane, coated side outside (wrapped)
8 (2)	Cellulose acetate P-912
10 (1)	Polyethylene
15	Cellophane-pliofilm laminate, pliofilm inside
16	Cellophane-polyethylene laminate, polyethylene inside
17	Cellulose acetate-pliofilm laminate, pliofilm inside
20	Trithene (wrapped)

(1) "Hand" made in the laboratory; (2) "hand" made by Celanese Corporation; all other film packages except No. 20 were "factory" made by Standard Packaging Corporation.

The containers were 5" by 6" pouches, made from the above materials. All pouches were sealed under 27 to 29 inches of vacuum, except package type 8 (cellulose acetate), which was sealed with a solvent at atmospheric pressure; film 15 in one run, which was sealed at atmospheric pressure; package type 6w, which was taped shut at atmospheric pressure; and package type 20, which was devoided of air as much as possible by hand pressure, folded over at the open end, and taped shut.

EXPERIMENTAL

Color measurement. The Hunter Color and Color-Difference Meter was used throughout the course of this 5-year study. In the last three-quarters of the investigation, the instrument was standardized with an enameled plate the approximate color of the samples. Previously, a white plate was used.

The L system of measurement was used, giving 3 values, as follows:

L scale—visual lightness

a_L scale—redness when plus, greyness when zero, and greenness when minus

b_L scale—yellowness when plus, greyness when zero, and blueness when minus.

Use of a_L or redness value. Since 3 values were obtained in each color determination, the problem of graphic presentation showing color change with time is apparent.

In the early part of the investigation (Runs A through O) the color changes were presented in terms of ΔE (as suggested by the Gardner Laboratories) where $\Delta E = \sqrt{\Delta L^2 - \Delta a^2 - \Delta b^2}$. The values ΔL, Δa, and Δb were differences betwen the readings on the sample and those on the standard. ΔE, therefore, decreased as the sample approached the standard in color.

It was found that a_L (redness) varied to a greater extent than L (lightness) or b (yellowness), both of which remained fairly constant even though the meat darkened considerably. The correlation coefficient between the ΔE value and the a_L value was -0.9. It was therefore decided that the results of the color readings could be presented in terms of the a_L value to give substantially the same results as the ΔE method. The only difference being that a_L increased with increasing redness and ΔE decreased.

To the best of the authors' knowledge, their use of the Hunter Meter in 1949 was the first systematic application of that instrument to the measurement of meat color.

It was desirable to be able to express color as a number; therefore, a study was made to determine whether or not reading of meat color on the Hunter Meter correlated significantly with hue and chroma designations of the Munsell system. The L_L, a_L, and b_L readings of a number of samples were converted individually by means of equations given by the Gardner Laboratories[e] to I.C.I. tristimulus values. These values were

[e] Originator and manufacturer of Hunter Color and Color-Difference Meter.

then converted to Munsell designations by means of chromaticity diagrams.

Thus, a series of values of each Hunter component was evaluated in terms of complete Munsell designations. Next step was to determine the degree of correlation between each Hunter component and both *hue* and *chroma*, individually, of the Munsell system. Since *value* in the Munsell system is practically identical to L value in the Hunter system, correlations with Munsell *value* were not made.

On cured meats, the b_L values showed significant correlation with both *chroma* and *hue*. On fresh meat, there was significant correlation only with *chroma*. The a_L values, however, showed highly significant correlation with both *hue* and *chroma* on both fresh and cured meat.

The L value of fresh meat changed only slightly with a substantial change in redness. The L value of cured meat not only varied more than it did with fresh meat, but it also varied directly with b_L and inversely with a_L. The L value of fresh meat did not show a significant correlation with either *hue* or *chroma*, whereas, on cured meat, it showed significant correlation with both *hue* and *chroma*.

Presumably, any one of the Hunter components could be used satisfactorily as an index to the color changes of cured meat. The highly significant correlation shown between a_L values and both *hue* and *chroma* seemed to qualify this component as a satisfactory index of the color of fresh meat. Therefore, a_L was adopted as the index.

Determination of initial redness value. Initial redness values of the meat were determined by taking color readings on the freshly ground and mixed meat or on the freshly churned cut samples immediately before storage. Procedure for ground meat was as follows: Enough meat for 4 samples was removed from the prepared meat in the refrigerator and taken in a covered tray to the Hunter Color and Color-Difference Meter. About 100 g. of meat was kneaded by hand to obtain a thoroughly mixed sample which was then placed in the exposure position on the instrument. After readings were taken, sample was turned over and readings were taken on the other side. The same procedure was followed for obtaining color values of the other 3 samples. In experiments where packaging was involved, samples were taken to the packaging room and packaged and sealed under about 27 inches of vacuum. They were then stored. Enough meat for 4 more samples was then removed from the refrigerator and the above procedure repeated until readings had been made on all samples. In experiments where the meat was not to be packaged but was to be stored in desiccators or some other container, samples were all stored at the same time after sufficient color readings had been taken to give a mean initial redness value. The a_L values were averaged and the result taken as representative of the color of the meat on zero day.

Initial redness value of cut samples was determined by obtaining the a_L values of top, bottom, and inside surfaces of representative samples. Inside redness value was obtained by cutting the sample lengthwise in a plane parallel to the broad surfaces of the sample, and determining the a_L value of one of the freshly exposed surfaces. These samples were otherwise handled in the same manner as the ground samples.

Determination of redness after storage. After the instrument was standardized, 2 or 3 samples at a time were removed from storage. Color readings were made on the top and bottom surfaces of the first sample. If the sample was ground meat, it was then kneaded by hand and color readings were taken of the mixture. If a cut sample, it was cut in a plane parallel to the broad surface and a color determination made of the freshly cut surface. This procedure was repeated with the remaining samples until all had been measured. Mean values for duplicate samples were always used.

Evaluation of results on change of color. Comparison of absolute redness values did not permit an evaluation of package types on any particular storage day among the various runs. Therefore, in order to evaluate the packaging materials among the various runs from the standpoint of maintenance of good commercial color, 2 sets of weighting factors were applied to the a_L values. These systems were designated as the *short* and *long*. The *short* system intensifies the differences in redness during the early part of the storage period, whereas the *long* places emphasis on the late portion of the storage period.

Weighted a_L values of each packaging material were compared with the weighted a_L values of the comparable "canned" control for that particular run. Thus, a good picture was obtained on the best film for any particular type of meat for either the short or long term holding.

In the short system, chosen as being particularly applicable to the present practices of prepackaging fresh meat by the retailer, the largest weighting factors were assigned to the first 4 days after packaging. This is the period within which the meat is usually sold. The long system was chosen as being applicable to an expected result of a present trend in marketing fresh meat, that is, the prepackaging of retail cuts of meat in a centrally located packing house before shipping to consumer outlets. If this type of marketing were used, the color during the first 2 or 3 days after packaging would not be as important as that during the 4th to the 8th day after packaging since the packages would be in transit during their early stages of storage. In the long system of evaluation, therefore, principal emphasis by the weighting factors was applied from the 4th to the 8th day after packaging.

Table 1 shows the weighting factors. Factors for only the first 12 days after packaging are listed. Although the samples may have good commercial color after this period, they may not be otherwise acceptable organoleptically.

TABLE 1

Weighting factors for evaluating samples in storage for color

System	Days after Packaging											
	1	2	3	4	5	6	7	8	9	10	11	12
Short	8	10	10	8	6.5	6	5.5	5.5	5	4.5	4	4
Long	2	4	7	9	10	10	9	8	6	5	4	3

To illustrate use of this table, we take the a_L value, after one day of storage, for the top surface of a cut "canned" control of fresh ham in Run GG. This was 6.6 units. In the short system, weighted rating value was 6.6 x 8 or 52.8 and in the long system, 6.6 x 2 or 13.2. These same factors were multiplied by the a_L value for the bottom surface of the cut "canned" control. These steps were repeated for each day of storage or for the first 12 days of storage if the run was long. Values obtained by multiplying the a_L values by corresponding weighting factors were totaled and the sample with the highest total was considered to be the best, as far as good red color was concerned.

Storage conditions depended on the factor to be studied during each experiment. The factor under investigation was varied while as many other conditions as possible were held constant. Any color changes could then be attributed to the intensity of the variable factor. In experiments in which packaged samples were stored in the Hill storage cabinet, there was an average temperature difference of 4° F. between the areas in which "replicate" samples were stored. Placing samples so that every set of replicates was subject to the same temperature conditions was considered better than having replicates of one storage condition at one average temperature and replicates of another storage condition at a different average temperature. This was done by placing one member of each set of duplicates at one average temperature and the other member at the other average temperature. When samples were stored in desiccators (Sections IIC and IID), the desiccators containing samples under a common storage condition were likewise stored in different temperature areas within the case.

The percentage of the volume of the container occupied by the meat may be of importance. It has a possible influence on the effect on the color change of meat of the various conditions specifically studied. When the meat samples were packaged in films, essentially 100% of the volume of the container was taken up by meat since the vacuum caused the film to "shrink" around the sample. When the meat was stored in a rigid container, such as a can or a desiccator, the percentage of the volume of the container taken up by meat depended on volume of the container and number and size

of meat samples within. In the experiments conducted in this phase of the work, cans of two different sizes and one size of desiccator were used. Only one sample was sealed in each can, whereas the number of samples sealed in the desiccators varied. It is estimated that each sample was about 90 cc. in volume. Approximate percentages of the various container volumes occupied by the meat samples were:

Container	Volume of Container	Number of Samples in Container	Percentage of Volume Occupied by the Sample
Can (307 x 306)	456 cc.	1	19.7
Can (307 x 113)	230 cc.	1	39.1
Desiccator	8500 cc.	3	3.2
Desiccator	8500 cc.	8	8.5
Desiccator	8500 cc.	12	12.7

Except in experiments designed to study effect of light on color change, samples were stored in the dark in all runs.

In most cases, effects of the different variables on color changes of meat have been determined a number of times. The experiments presented in this report are representative of the results obtained in all similar experiments. Instances where there were discrepancies between results of the experiment presented and those of other experiments not presented will be discussed in Results and Discussion.

RESULTS

Hunter meter. Figures 1, 2, 3, and 4 show the redness changes of ment stored in various packages. Each graph shows results obtained in a typical run of the project. On each graph, an arbitrary interpretation of visual color acceptability, in terms of a_L values is indicated. The upper value, marked *desirable*, is that above which the average consumer probably would not be influenced by color differences. The lower value, marked *undesirable*, is that below which the average consumer probably would regard the meat as unacceptable. Thus, *desirable* and *undesirable* values constitute the upper and lower limits, respectively, for *satisfactory*, but not preferred, color. An a_L value exceeding the upper limit is extremely desirable; the higher the a_L value the better the red color for the sample. A sample having an a_L value below the lower limit is unsatisfactory with regard to color. These arbitrary limits were based upon the experience of a color judging committee.

Figure 1 shows the change in a_L or redness value of ground pork packaged in package types 2, 15, and 17. "Canned" samples usually showed a return in redness after initial darkening, although time and extent of redness return varied in different runs.

Figure 2 shows redness changes of ground lamb packaged in package types 2, 6a and 6d. "Canned" samples showed a longer period of decrease in redness than was usually the case. There was also only a moderate return in redness. If the storage period had been continued longer than 20 days, a further increase in redness might have occurred.

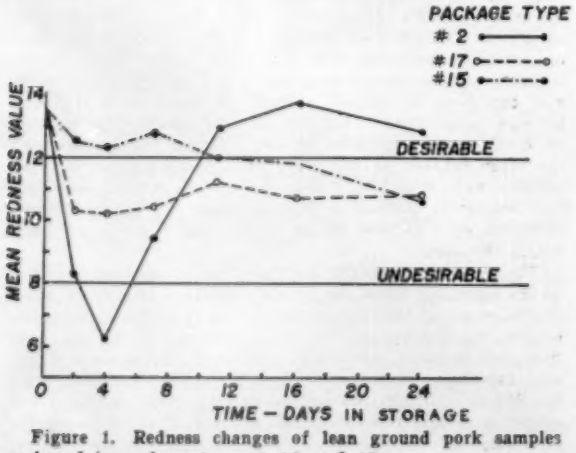

Figure 1. Redness changes of lean ground pork samples packaged in package types 2, 15, and 17.

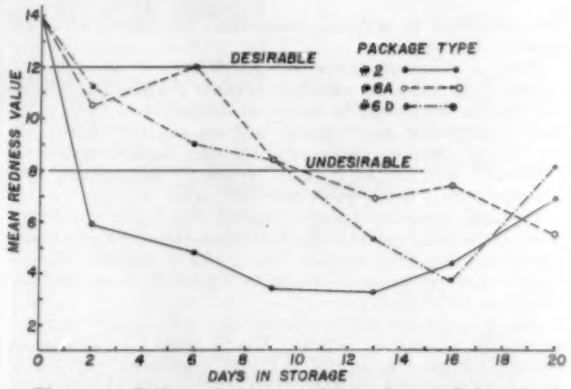

Figure 2. Redness for top surfaces of ground lean lamb samples packaged in package types 2, 6a, and 6d.

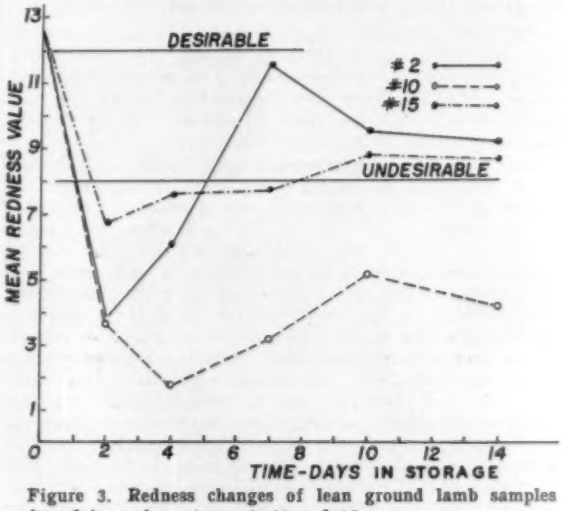

Figure 3. Redness changes of lean ground lamb samples packaged in package types 2, 10 and 15.

Figure 3 shows redness values obtained from ground lamb samples packaged in package types 2, 10 and 15. The initial decrease in redness of meat in film 10 is typical for meat stored in this film, although the subsequent increase in redness was not always found.

Figure 4 shows redness values for cut and ground samples of lamb packaged in package types 2, 15, 6d, and 6w. (Package types 6d and 6w are both MSAT80 cellophane. The former is a pouch, the latter, wrapped.)

As a basis for evaluating effects of the different packages on the color of samples stored in them, ratios of the weighted a_L values of the "canned" control were used. Weighted values for the meat in each of the package types were obtained by multiplying the a_L value on each day by the weighting factor for the day obtained from Table 1 and then totaling these values. The a_L values were taken from a curve in which a_L was plotted against days of storage. Some runs involved a storage period of only 7 rather than the 12 days needed to rate the packages on the 12-day weighting factor system. It was decided to calculate the package types on both 12- and 7 day bases. Weighting factors used for the 7-day period were adjusted to give a total of 51 units in each set of factors. This was done by reducing the short term factors shown in Table 1 by 3 units to give a factor of 6 for the 5th day, 5 for the 6th day, and 4 for the 7th day. Ratios obtained from these weighting factors are presented in Table 2. Those package types marked with an asterisk are given ratios calculated on the 7-day basis; unstarred package types are given values on the 12-day basis. In a case in which one type of

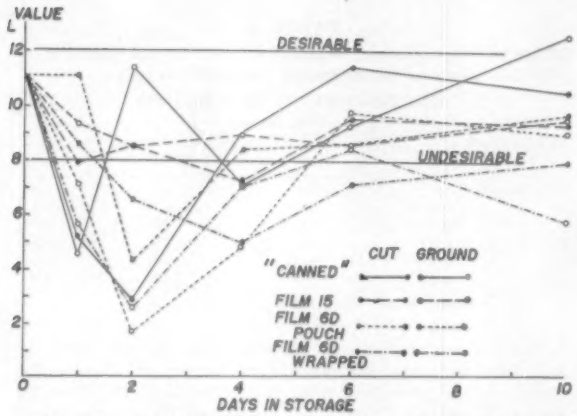

Figure 4. Average "a" values for top surfaces of lean cut and ground lamb samples packaged in package types 2, 15, 6d pouch, and 6d wrapped.

sample was packaged in the same type of package in several runs, ratios obtained in all of these runs were averaged. When interpreting Table 2, one should keep in mind the number of runs from which the ratios were obtained. In a case in which samples were packaged in a certain film only once, the ratio is the one given in Table 2. For instance, ratings of the samples packaged in film 4a are those obtained from Run O alone. However, values of the ratios for lean ground samples of lamb packaged in film 6d (7-day basis) are an average of the ratios obtained in Runs Q, R, HH, II, and JJ. Thus, these latter ratios may be considered to be better substantiated than the ratios obtained for film 4a.

This ratio method of making comparative evaluations of the films was chosen for the following reasons. It was apparent that absolute ratings of meat in a film could not be compared with absolute ratings of meat in another film if the ratings for the 2 films were obtained in different runs. Since the "canned" control was used as a package type in all runs, the ratio (film to can), in the same run, was considered the most reliable index to the rating of a film. Any indication of the superiority of one film over another does not mean that the same relationship would necessarily be shown by absolute values of color ratings. In fact, the color ratings of the "canned" control in one run may differ considerably from the ratings of the "canned" control in another.

By means of Table 2, one can get an approximation as to which package types are best for a particular kind of meat. Films 15 and 17 appear to be the best package types for ground lamb. Rating values obtained in one run for film 17 were not significantly different from those of samples packaged in film 15 in 9 runs.

Ground pork samples packaged in film 6d were better in color than ground pork samples packaged in film 6w although there was not much difference between the 2 films in maintaining the color of cut pork samples. Film 15 was the best for maintaining color of ground pork samples, whereas films 6d and 6w were best for cut pork samples.

Film 4a appears to be the best package for lean ground beef and film 8 for fat ground beef.

In Run LL, a cursory study was made of film 20. Types of meat used were beef and cured ham. Only 6 pouches of trithene (film 20) were available. One ground and one cut sample of beef were packaged in film 20 and stored in the dark. One ground sample of beef, packaged in film 20, was stored in the light. One ground and one cut sample of cured ham were packaged in film 20 and stored in the light and one ground sample of cured ham, packaged in film 20, was stored in the dark. The same packaging procedures were used in Run LL for samples packaged in film 15. Cut and ground samples of beef and cured ham, which served as controls, were sealed in package 2, under 27 inches of vacuum. Before and after packaging in the films, the a_L values were determined. Because of the small number of samples available, all readings after packaging were taken through the film.

In order to establish a basis for interpretation of color readings made in surfaces covered with films in comparison with the readings made on uncovered surfaces, the readings were analyzed to determine the distortion effects produced by the covering films upon the a_L values. Table 3 shows the difference between a_L value before a sample was packaged and that after packaging. For example, a sample of beef, EA20, top surface, had an a_L value of 19.8 immediately prior to packaging and an a_L value of 20.2 through the packaging material (film 20) immediately after packaging. Thus, the value in the table is +0.4, the difference obtained by subtracting the a_L value of the uncovered sample before packaging from the a_L value of the sample, covered by the film, immediately after packaging.

TABLE 2

Ratios of weighted color ratings of meat in film packages to those of meat in control can

Film	Run	Type of Meat	Cut or Ground	*Lean*		*Fat*	
				Short	Long	Short	Long
		Beef					
4a	O		ground	1.27	1.31	0.96	0.98
4a*	O		ground	1.34	1.43	0.95	0.98
6	H		ground	1.03	1.02	1.32	1.42
6*	H		ground	1.08	1.08	1.33	1.45
8	O		ground	1.05	1.05	1.38	1.49
8*	O		ground	1.24	1.26	1.43	1.61
15	H,J		ground	0.87	0.86	0.89	0.91
15*	H,J		ground	0.92	0.91	1.00	1.02
15	W,X,CC,EE		cut	1.09	1.03		
15*	W,X,CC,EE		cut	1.04	1.08		
16	K		ground	0.85	0.84	1.02	1.06
16*	K		ground	0.89	0.88	1.20	1.33
		Lamb					
6a	N,P,Q		ground	0.97	0.95	1.22	1.23
6a*	N,P,Q		ground	1.02	1.00	1.30	1.35
6d	Q,R,II		ground	0.86	0.86		
6d*	Q,R,II,HH,JJ		ground	0.77	0.74		
6d	Q,R		ground			1.32	1.33
6d*	Q,R		ground			1.54	1.51
6d*	HH,II,JJ		cut	0.97	0.80		
6w*	HH,II,JJ		ground	0.52	0.48		
6w*	HH,II,JJ		cut	0.91	0.76		
10	T,U,V		ground	0.47	0.39	0.51	0.32
10*	T,U,V		ground	0.49	0.37	0.89	0.62
15	I,N,P,R,T,U,V,II		ground	1.15	1.13		
15*	I,N,P,R,T,U,V,II,JJ		ground	1.18	1.18		
15	I,N,P,R,T,U,V		ground			1.17	1.17
15*	I,N,P,R,T,U,V		ground			1.66	1.28
15*	II,JJ		cut	1.21	1.09		
17	I		ground	1.22	1.25	1.20	1.29
17*	I		ground	1.27	1.32	1.36	1.54
		Pork					
6d	S		ground	0.89	0.84		
6d*	GG,S		ground	0.65	0.59		
6d*	GG		cut	1.44	1.67		
6w*	GG		ground	0.38	0.31		
6w*	GG		cut	1.46	1.67		
15	L,M,S		ground	1.13	1.07		
15*	L,M,S		ground	1.31	1.22		
15	L,M		ground			1.25	1.25
15*	L,M		ground			1.43	1.46
15	Y,Z,AA,BB		cut	1.02	0.97		
15*	Y,Z,AA,BB		cut	1.15	1.06		
15	AA,BB		cut			1.02	0.99
15*	AA,BB		cut			1.08	1.05
17	M		ground	1.03	1.06	0.93	1.00
17*	M		ground	1.13	1.18	0.94	1.06

* Note: Asterisks after film designation denote that ratios were based on 7 days of storage, all other ratios were based on 12 days of storage.

Generally speaking, on packaging day and after 21 days of storage, a_L values for unpackaged beef samples were less than those of the same samples covered with the packaging material. However, a striking exception to this rule occurred in the packaging day determinations on 5 out of 6 samples packaged in film 15.

In all lots of samples, discrepancies between the algebraic differences of packaging day and those of removal day are large enough that one must take them into consideration when trying to evaluate this system of measuring color.

Were it not for the fact that the changes in color in the beef and cured ham seem to be more consistently related to type of meat than to type of package, one might reasonably

assume that the discrepancies in measuring color through the package were caused by a change in the optical properties of the packaging material during the storage period. Presence of a certain form of myoglobin in greater concentration at one time than at the other might also account for the changes. The probability is strong that the discrepancies between the algebraic differences on packaging day and those on removal day were due to a combination of these and some unknown factors.

A special study of the technic of measuring color through the film will be described in a subsequent report.

In analyzing the results of Run LL, in view of the discrepancies shown in Table 3, just discussed, no corrections were made in the readings of a_L which were made on surfaces covered with a film. Therefore, all a_L values were used without modification, regardless of whether they applied to a film covered surface or to a non-covered surface.

Table 4 presents ratios of the weighted ratings for color of the samples of beef in films 20 and 15 to the ratings of the corresponding "canned" controls (Run LL), calculated under both the short and the long term weighting systems.

In dark storage of cured meat in Run LL, there was little difference in performance between films 15 and 20. When the samples were stored in the light, however, the sample packaged in film 15 were vastly superior to similar samples packaged in film 20.

TABLE 3

Excess of a_L value of sample covered by film over that of uncovered sample

Sample	Packaging Day		Removal Day	
	Top	Bottom	Top	Bottom
EA 20	+ 0.4	+ 4.7	+ 0.5	+ 1.1
LA 20	+ 0.2	0.0	+ 0.8	− 0.2
LL 20	+ 0.0	− 1.0	+ 6.3	+ 1.4
WL 20	+ 1.9	+ 0.7	− 2.2	− 0.8
AA 20	+ 1.0	+ 1.9	− 1.9	− 2.5
AL 20	+ 1.3	+ 1.5	− 1.1	− 1.7
EA 15	− 1.4	− 2.7	+ 3.0	+ 4.1
LA 15	− 0.5	− 2.1	+ 2.3	+ 2.2
LL 15	+ 1.4	− 3.3	+ 1.4	+ 0.3
WL 15	− 0.3	+ 0.1	− 0.2	− 1.2
AA 15	+ 2.1	+ 2.0	− 1.2	− 0.5
AL 15	+ 1.1	+ 1.8	− 0.9	− 1.5

Note: Number 20 or 15 refers to type of package
EA — cut sample of beef in dark storage
WL — cut sample of cured ham in light storage
LA — ground sample of beef in dark storage
LL — ground sample of beef in light storage
AA — ground sample of cured ham in dark storage
AL—ground sample of cured ham in light storage
Storage period was for twenty-one days.

TABLE 4

Ratios of weighted color readings of beef in film packages to those of corresponding "canned" controls

(Run LL—Light vs. Dark Storage)

(12-Day Basis)

	Sample	Storage	Short	Long
Film 20	cut	Dark	1.03	1.03
	ground	Dark	0.49	0.44
	ground	Light	0.52	0.46
Film 15	cut	Dark	0.85	0.88
	ground	Dark	0.56	0.53
	ground	Light	0.46	0.43

NOTE: Storage period was twenty-one days.

Table 5 lists the package types in order, starting from the best for long-period storage to the poorest for long-period storage. This table is divided into 2 sections, the first for samples stored for 12 days and the second for samples stored for 7 days. The best package types for long period storage, based on ratios for seven days of storage, were:

1. lean cuts of beef — No. 15
2. ground lean beef — No. 4a
3. ground fat beef — No. 8
4. lean cut lamb — No. 15
5. ground lamb or fat lamb — No. 17
6. cut lean pork — No. 6w
7. cut fat pork and ground pork, fat and lean — No. 15

Table 6 lists the package types in order starting from the best for short-period storage to the poorest for short-period storage. The order of the packages in Table 6 is practically identical to the order in Table 5. Differences occurred with ground, fat and lean samples of beef in Part II, ground lean samples of lamb in Part II, ground fat samples of lamb in Parts I and II, fat and lean cuts of pork in Parts I and II, and ground fat samples of pork in Parts I and II. The listings in Tables 5 and 6 reflect the ratio data of Table 2.

Package type 15, it will be noted in Tables 5 and 6, seems to be better for lean ground meat than for fat ground meat. The cellophane packages usually give the opposite result. The long-period system of evaluation emphasizes this relationship more than the short-period system.

DISCUSSION

That film 15 was a better film than 6d or 6w in maintaining the color of lamb has been stated. It should be kept in mind, however, that the weighting values used to evaluate the various films cover the

TABLE 5

Descending order of package types from the best to the poorest in the long-period system of evaluation for 7 and 12 days of storage

Part	BEEF				LAMB				PORK			
	Cut		Ground		Cut		Ground		Cut		Ground	
	Lean	Fat	Lean	Fat	Lean	Fat	Lean	Fat	Lean	Fat	Lean	Fat
I	15		4a*	8*	2		17*	6d	2	2	15	15
	2		8*	6*	6d*		15	17*	15	15	17*	17
			6*	16*			2	6a			2	2
			2	2			6a	15			6d*	
			15	4a*			6d	2				
			16*	15			10	10				
II	15		4a*	8*	15		17*	17*	6w*	15	15	15
	2		8*	6*	2		15	6d	6d*	2	17*	17
			15	16*	6d		2	6a	15		2	2
			6*	15	6w		6a	15	2		6d	
			2	2			6d	2			6w*	
			16*	4a*			6w	10				
							10					

Note: Part I is based on ratios determined for a 12-day storage period.
Part II is based on ratios determined for a 7-day storage period.
* Rating based on data from only one run.

TABLE 6

Descending order of package types from the best to the poorest in the short-period system of evaluation for 7 and 12 days of storage

Part	BEEF				LAMB				PORK			
	Cut		Ground		Cut		Ground		Cut		Ground	
	Lean	Fat	Lean	Fat	Lean	Fat	Lean	Fat	Lean	Fat	Lean	Fat
I	15 2		4a* 8* 6* 2 15 16*	8* 6* 16* 2 4a* 15	2 6d*		17* 15 2 6a 6d 10	6d 6a 17* 15 2	15 2	15 2	15 17* 2 6d*	15 2 17
II	15 2		4a* 8* 6* 2 15 16*	8* 6* 16* 2 15 4a*	15 2 6d 6w		17* 15 6a 2 6d 6w 10	15 6d 17* 6a 2 10	6w* 6d* 15 2	15 2	15 17* 2 6d 6w*	15 2 17

Note: Part I is based on ratios determined for a 12-day storage period.
Part II is based on ratios determined for a 7-day storage period.
* Rating based on data from only one run.

first 7 or 12 days of storage. In several instances, samples in other package types, such as 6a or 6d, may have been higher in redness for the first 1 or 2 days of storage than samples packaged in film 15. However, samples packaged in films 6a and 6d, after 2 days of storage, usually lost redness very rapidly, while samples packaged in film 15 remained quite constant in redness after an initial moderate decrease in redness. This relationship was not generally made apparent by weighted color ratings calculated for a period of either 7 or 12 days. When the period was shortened to one day, in Run II for example, weighted value under the short system for cut samples of lamb packaged in film 6d was 190 and weighted value for cut samples of lamb packaged in film 15 was 134. For any storage period longer than 2 days, however, cut samples packaged in film 15 had a higher weighted value than cut samples packaged in film 6d. This indicates that, if a retailer anticipated selling cuts of lamb within 2 days after packaging, film 6d would be a logical package type to use. But, if the time of sale is to be at a later date, he would do better using film 15, sealed under vacuum.

Results of Rikert and Miles in this investigation indicate that no one flm is best suited for packaging all types of meat. The best results, as far as color is concerned, are obtained by packaging each type of meat in a specific package. For example, the data, based on calculations for a 7-day period, indicate that, for long-period storage, film 15 is the best package type for lean cuts of lamb and ground samples of pork, but film 6d is a better film for packaging cuts of pork. It is probable that film 15 would be a better film for cuts of pork if the evaluation were based upon the 12-day instead of the 7-day period, as film 15 is better film for the long period of storage. Data for pork cuts in film 6d, however, are not available for a period of 12 days. In most cases, the difference between short and long storage, as shown by the rating system used in this investigation, is not significant, but some films were considerably better for the short period than for the long. These films are:

Cut lean beef	film 15
Cut lean lamb	film 6d, film 6w
Cut lean pork	film 6w, film 6d
Ground lean lamb	film 6w, film 6d, film 10
Ground fat lamb	film 10 film 6d, film 6a
Ground lean pork	film 6w, film 6d

Note: The films are placed in descending order, with the film having the largest ratio, of short vs. long, first.

SUMMARY

To summarize, Tables 5 and 6 present the types of packages, arranged in descending order, with the best type of package for maintaining the red color of each kind of meat first. The package types are arranged in both tables on the basis of both 7- and 12-day storage periods. All films except 6w, 8, and 20 were sealed under 27 to 29 inches of vacuum.

Lamb. Film 15 (cellophane-pliofilm laminate) was one of the best for maintaining good color in cut and ground samples of lamb during either 7 or 12 days of storage. Film 17 (cellulose-acetate-pliofilm laminate) was also a good film for maintaining the color of ground lamb. This film, however, was used in only one run. Film 6d (MSAT80, pouch, coated side out) was better than film 6w (MSAT80, wrapped, coated side out) for maintaining the color of both cut and ground samples of lamb.

Beef. Of the package types used with beef, viz, 2, 4a, 6, 8, 15, ad 16, film 4a (vinyldene copolymer) was the best package for maintaining good color in lean ground beef. Film 8 (cellulose acetate) was the best package for fat ground beef. In each case, the rating is based on data from only one run.

Pork. Film 15 was best for ground lean and fat pork, followed by films 17, 6d, and 6w, in that order. The effect of film 6d on lean cut pork was quite similar to that of film 6w; both films were better than film 15.

LITERATURE CITED

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Sampling Plans Developed by United States Department of Agriculture for Inspection of Processed Fruits and Vegetables[a, b]

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THE PROCESSED PRODUCTS STANDARDIZATION and Inspection Branch of the Agricultural Marketing Service is engaged in two major fields of activity. One is the development of U. S. Grade Standards for processed fruit and vegetable products and revising those standards when the need arises, and the other is making inspection service available to industry. In performing these activities personnel of the Branch are always confronted with destructive sampling of product in standardization studies and also in inspection procedures. Some of the sampling procedures developed by the Department will be presented, but first a brief explanation of the concepts of a sound sampling plan will be in order.

In general, there are two types of sampling employed in the inspection of a product. One is by *attributes* and the other by *variables*. By *attributes*, the characteristic of a product is judged as conforming or not conforming to a specified requirement. The degree of conformance or non-conformance may or may not be measured. By *variables*, the characteristic of a product is determined by actual measurement and will not only reveal conformance or nonconformance, but will indicate the degree of conformance to a specified requirement. The present study will largely be confined to sampling by *attributes*.

DISCUSSION OF PROCEDURES

AQL. In developing a sampling acceptance plan by *attributes*, the first point that must be clearly understood and accepted is the fact that no sampling plan can guarantee that the portion of the product not inspected will possess equal or better quality than that of the sample. Every sampling acceptance plan involves a chance of accepting some defective quality product in the lot. Therefore, one must recognize this fact and, on the basis of expert knowledge of the product to be sampled, decide what percentage of defective product would be acceptable in the lot. This percentage is often called Acceptance Quality Level (AQL). Sometimes it may be desirable to classify defective product according to the severity of the defects. For example, one might define two types of defects, major and minor, and specify that any sample unit possessing minor defects only is a minor defective of which one is willing to accept, say, 5% in the lot. Those units possessing major defects only; or both major and minor defects, will be major defectives, of which one will accept, say, 1% in the lot.

Once the AQL's have been established, the buyer's and seller's risks must be determined. The buyer's risk may be defined as the percentage of the time that lots are accepted that are worse than the AQL or the AQL + X percent. The seller's risk is the percentage of time that lots equal to or better than the AQL are rejected. Thus, these decisions are the basis for a formal sampling plan.

To establish the lot-by-lot acceptance plan by *attributes* one now needs only 3 numbers:

1—N, the lot size

2—n, the sample size and

3—c, the acceptance number, *i.e.*, the maximum number of defectives or defects permitted in an acceptable sample.

OC. Then one can compute Operating Characteristic (OC) curves to show what the particular plan does for various percent defective lots. Some OC curves are illustrated in Figure 1. It can be seen in Figure 1 that each of the curves represents a 10% sample. The curves clearly demonstrate the inadequacy of straight percentage sampling. The basic reason for prescribing a straight percentage sample is the belief that each lot of the same quality will then have an equal chance of acceptance; however, it is obvious from Figure 1, that this is not so. For example, for a lot containing 6% defective, the plan for the top curve accepts this lot about 72% of the time, the next plan accepts approximately 52% of the time, the third 27% of the time, and the plan for the bottom curve accepts less than 1% of the time.

Contrary to this rather common belief, the size of the sample and the acceptance number (irrespective of the lot size) are the deciding factors for accepting and rejecting a lot containing any given percent defective. Figure 2 illustrates this fact very clearly.

Figure 2 contains OC curves for a mixed sample size of 20 and an acceptance number of 0, with varying lot sizes. The 5 curves are in fairly close agreement irrespective of lot size. For example, a sample of 20 units from a lot containing an infinite number of units gives almost the same protection as a sample size of 20 from a lot containing 100 units. Therefore, from a statistical standpoint the lot size, N, would not be needed to establish a lot-by-lot acceptance sampling plan by *attributes*. However, there are economical factors such as time and cost of sampling that must be considered with respect to lot size. When destructive sampling is necessary, this cost factor becomes even more important and generally results in compromising risks, sample sizes, and AQL's.

This is essentially the problem confronting many types of food inspection, particularly the type of inspection which this Branch is called upon to perform. For this type of inspection the portion of the product inspected is either consumed (for test purposes) or rendered unfit for sale due to other tests and examinations on the product. Therefore, the sample size must of necessity be limited, regardless of any statistical consequences.

[a] The sampling plans presented in Tables 1 through 6 of this study have been incorporated in the Regulations Governing Inspection and Certification of Processed Fruits and Vegetables and Related Products, effective July 1, 1957.

[b] Presented at the 17th Annual Meeting of the Institute of Food Technologists, Pittsburgh, Pennsylvania, May 15, 1957.

These concepts and restrictions were of utmost importance in guiding the Department's development of the sampling plans to be presented. These plans are for quality inspection, that is, they are for use in determining the U. S. Grade of a lot of processed foods offered to the Department of Agriculture for inspection.

The sampling is on an *attribute* basis and the first step in the development of the plans was to define defective product and establish an AQL.

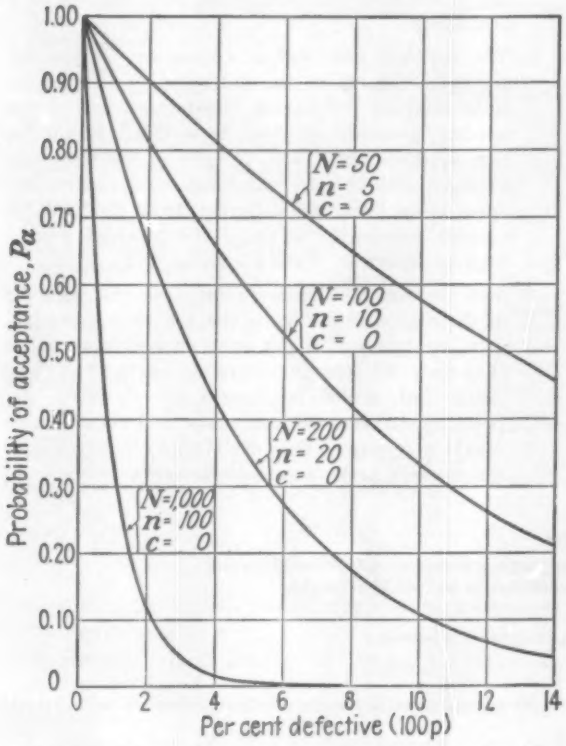

Figure 1.—Comparison of characteristic curves for four sampling plans involving 10% samples.

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"Deviation" and "deviant." After study, we defined *deviation* and *deviant* to be synonymous with the generally accepted sampling terms *defect* and *defective*, respectively. This was necessary to avoid conflict with other previously established usage of the words *defect* and *defective* in our Standardization program. In the general definition deviation means any specifically defined variation from a particular requirement, and *deviant* means any sample unit containing one or more deviations or any sample unit that varies in a specifically defined manner from the requirements of a standard, specification, or other inspection document. For the purpose of quality inspection, a lot is assigned U. S. Grade A, B, or C or denoted as "Substandard" or "Grade not Certified." A sample unit is assigned a grade based on score points such as 90–100 for A, 80–89 for B, and 70–79 for C; but may be assigned a lower grade than indicated by the score under certain limiting conditions which are sometimes prescribed for a specific product. In this usage, a *deviant* is specifically defined as a sample unit that falls into the next grade below the indicated grade but does not score more than 4 points below the minimum total score for the indicated grade. For example, if the indicated grade was A, and the score for A was 90–100, a sample unit scoring 91 points but assigned Grade B due to a limiting rule would be classed as a deviant. Likewise, a sample unit scoring 86 to 89 points would be a deviant when the Grade A requirement is considered.

The AQL was then established at 6% deviant, meaning any lots containing 6% or less deviants would be considered of acceptable quality for the indicated U. S. Grade. The 6% was the acceptance level agreed upon years ago, and it is currently in use.

BUYERS' AND SELLERS' RISKS

The problem of buyers' and sellers' risks, and sample size came next. In order to evaluate properly the risks involved, OC curves for various sample sizes and acceptance numbers were computed. Then, those that were most suited to our needs were selected. They are presented in Figure 3. The curves in Figure 3 are such that for lots containing 6% or less deviant product all of the various sampling plans will pass those lots of 95% of the time or more, excepting the plan for 3-sample units and an acceptance number of 0. One may also observe that the curves become steeper as the sample size increases which means that lots containing more than 6% deviant product will fail more often as the sample size increases. This is a desirable feature since when the value of the lot increases we also increase sample size.

The best curve of the group is that for the 72-sample units and an acceptance number of 8. In fact, were it not for destroying the product and the time and cost of examining 72-sample units this would

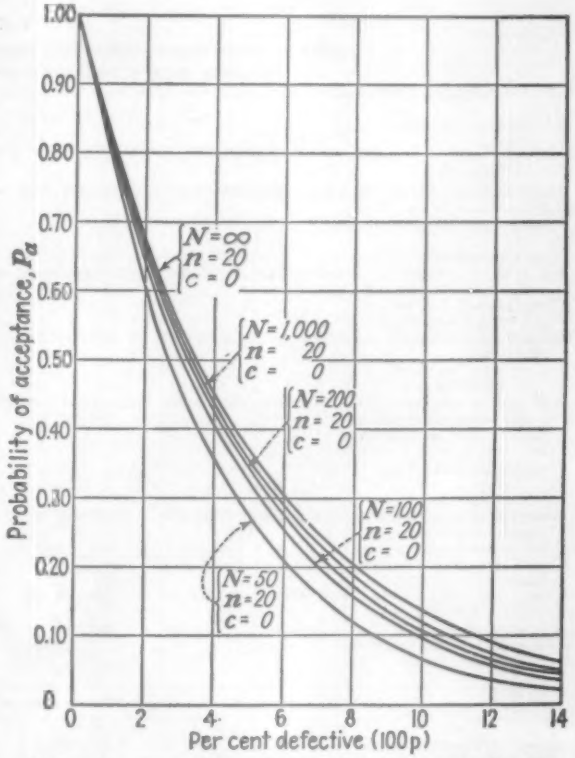

Figure 2.—Comparison of characteristic curves for five sampling plans involving samples of 20, each with the acceptance number of 0.

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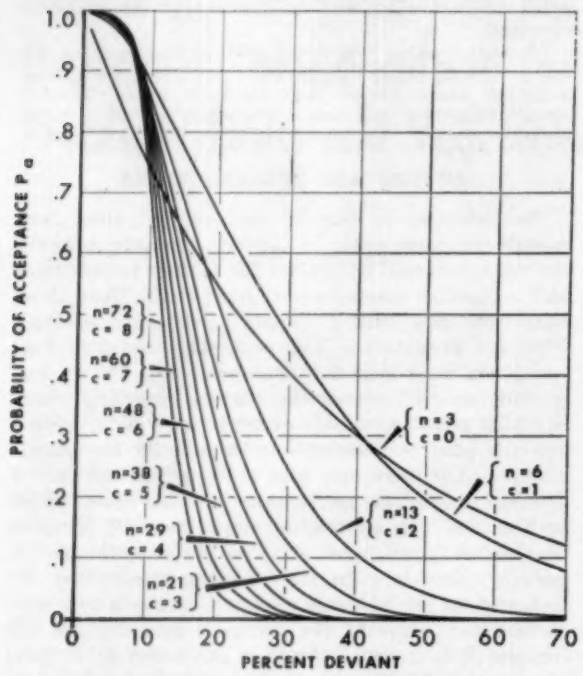

Figure 3.—Operating characteristic curves for quality single sampling plans—AQL = 6.0 percent.

perhaps be the only single sampling plan needed. However, in view of the destruction, time, and cost factors involved it was necessary to provide smaller sample sizes. It is at this point that lot size and container size become important considerations. Following are the reasons:

1. The lot size, sample size and container size directly determine the amount of product remaining to sell after the sample has been selected and destroyed.
2. The number and size of containers in the lot partially determine the dollar value of the lot to be sampled. Of course, the dollar value of the specific product involved is a third factor in this determination, but, at present we have not grouped products by value alone. Since we inspect more than 300 different food products, it seemed reasonable to make the product groupings as shown in Tables 1 through 5.
3. The lot size is directly related to the number of deviant containers in the lot. For example, a lot containing 10 per cent deviant may mean that only 40 containers are deviants or it may mean that 40,000 containers are deviants, depending on the lot size only. Obviously, one would not want to accept 40,000 deviant containers as often as he would 40 deviants.

TABLE 1

Canned or similarly processed fruits, vegetables, fishery products, and products thereof containing units of such size and character as to be readily separable

Container size group	Lot size (number of containers)								
GROUP 1 Any type of container of less volume than that of a No. 300 size can (300 x 407).	3,600 or less	3,601–14,400	14,401–48,000	48,001–96,000	96,001–156,000	156,001–228,000	228,001–300,000	300,001–420,000	Over 420,000
GROUP 2 Any type of container of a volume equal to or exceeding that of a No. 300 size can, but not exceeding that of a No. 3 cylinder size can (404 x 700).	2,400 or less	2,401–12,000	12,001–24,000	24,001–48,000	48,001– 72,000	72,001–108,000	108,001–168,000	168,001–240,000	Over 240,000
GROUP 3 Any type of container of a volume exceeding that of a No. 3 cylinder size can, but not exceeding that of a No. 12 size can (603 x 812).	1,200 or less	1,201– 7,200	7,201–15,000	15,001–24,000	24,001– 36,000	36,001– 60,000	60,001– 84,000	84,001–120,000	Over 120,000
GROUP 4 Any type of container of a volume exceeding that of a No. 12 size can, but not exceeding that of a 5-gallon container.	200 or less	201–800	801–1,600	1,601–2,400	2,401–3,600	3,601–8,000	8,001–16,000	16,001–28,000	Over 28,000
GROUP 5 Any type of container of a volume exceeding that of a 5-gallon container.	25 or less	26–80	81–200	201–400	401–800	801–1,200	1,201–2,000	2,001–3,200	Over 3,200.
	Single sampling plans [1]								
Sample size (number of sample units). [2]	3	6	13	21	29	38	48	60	72
Acceptance number.....	0	1	2	3	4	5	6	7	8

[1] For extension of the single sample sizes beyond 72 sample units, refer to table VI of this section; for multiple sampling plans comparable to the various single sampling plans refer to table VII of this section.

[2] The sample units for the various container size groups are as follows: Groups 1, 2, and 3—1 container and its entire contents. Groups 4 and 5—approximately 2 pounds of product. When determined by the inspector that a 2-pound sample unit is inadequate, a larger sample unit may be substituted.

TABLE 2

Frozen or similarly processed fruits, vegetables, fishery products, and products thereof containing units of such size and character as to be readily separable

Container size group	Lot size (number of containers)								
GROUP 1 Any type of container of 1 pound or less net weight.	2,400 or less	2,401–12,000	12,001–24,000	24,001–48,000	48,001–72,000	72,001–108,000	108,001–168,000	168,001–240,000	Over 240,000
GROUP 2 Any type of container over 1 pound but not over 4 pounds net weight.	1,800 or less	1,801–8,400	8,401–18,000	18,001–36,000	36,001–60,000	60,001–96,000	96,001–132,000	132,001–168,000	Over 168,000
GROUP 3 Any type of container over 4 pounds but not over 10 pounds net weight.	900 or less	901–3,600	3,601–10,800	10,801–18,000	18,001–36,000	36,001–60,000	60,001–84,000	84,001–120,000	Over 120,000
GROUP 4 Any type of container over 10 pounds but not over 100 pounds net weight.	200 or less	201–800	801–1,600	1,601–2,400	2,401–3,600	3,601–8,000	8,001–16,000	16,001–28,000	Over 28,000
GROUP 5 Any type of container over 100 pounds net weight.	25 or less	26–80	81–200	201–400	401–800	801–1,200	1,201–2,000	2,001–3,200	Over 3,200
Single sampling plans [1]									
Sample size (number of sample units).[2]	3	6	13	21	29	38	48	60	72
Acceptance number	0	1	2	3	4	5	6	7	8

[1] For extension of the single sample sizes beyond 72 sample units, refer to table VI of this section; for multiple sampling plans comparable to the various single sampling plans refer to table VII of this section

[2] The sample units for the various container size groups are as follows: Groups 1, 2, and 3—1 container and its entire contents. Groups 4 and 5—approximately 3 pounds of product. When determined by the inspector that a 3-pound sample unit is inadequate, a larger sample unit or 1 or more containers and their entire contents may be substituted for 1 or more sample units of 3 pounds.

TABLE 3

Canned, frozen, or otherwise processed fruits, vegetables, related products, and products thereof of a comminuted, fluid, or homogenous state

Container size group[1]	Lot size (number of containers)								
GROUP 1 Any type of container of 12 ounces or less.	5,400 or less	5,401–21,600	21,601–62,400	62,401–112,000	112,001–174,000	174,001–240,000	240,001–360,000	360,001–480,000	Over 480,000
GROUP 2 Any type of container over 12 ounces but not over 60 ounces.	3,600 or less	3,601–14,400	14,401–48,000	48,001–96,000	96,001–156,000	156,001–228,000	228,001–300,000	300,001–420,000	Over 420,000
GROUP 3 Any type of container over 60 ounces but not over 160 ounces.	1,800 or less	1,801–8,400	8,401–18,000	18,001–36,000	36,001–60,000	60,001–96,000	96,001–132,000	132,001–168,000	Over 168,000
GROUP 4 Any type of container over 160 ounces but not over 10 gallons or 100 pounds whichever is applicable.	200 or less	201–800	801–1,600	1,601–3,200	3,201–8,000	8,001–16,000	16,001–24,000	24,001–32,000	Over 32,000
GROUP 5 Any type of container over 10 gallons or 100 pounds whichever is applicable.	25 or less	26–80	81–200	201–400	401–800	801–1,200	1,201–2,000	2,001–3,200	Over 3,200
GROUP 6–HONEY ONLY Any type of container of a volume equal to or exceeding that of a 5-gallon container.	.....	20 or less	21–150	151–400	401–800	801–1,200	1,201–2,000	2,001–3,200	Over 3,200
Single sampling plans [2]									
Sample size (number of sample units).[3]	3	6	13	21	29	38	48	60	72
Acceptance number	0	1	2	3	4	5	6	7	8

[1] Ounces pertain to either fluid ounces of volume or avoirdupois ounces of net weight whichever is applicable for the product involved.

[2] For extension of the single sample sizes beyond 72 sample units, refer to table VI of this section; for multiple sampling plans comparable to the various single sampling plans refer to table VII of this section.

[3] The sample units for the various container size groups are as follows: Groups 1, 2, and 3—1 container and its entire contents. A smaller sample unit may be substituted in group 3 at the inspector's discretion. Groups 4, 5, and 6—approximately 16 ounces of product. When determined by the inspector that a 16-ounce sample unit is inadequate, a larger sample unit may be substituted.

TABLE 4
Dehydrated (low-moisture) fruits and vegetables

Container size group	Lot size (number of containers)								
GROUP 1 Any type of container of 1 pound or less net weight	1,800 or less	1,801–8,400	8,401–18,000	18,001–36,000	36,001–60,000	60,001–96,000	96,001–132,000	132,001–168,000	Over 168,000
GROUP 2 Any type of container over 1 pound but not over 6 pounds net weight.	900 or less	901–3,600	3,601–10,800	10,801–18,000	18,001–36,000	36,001–60,000	60,001–84,000	84,001–120,000	Over 120,000
GROUP 3 Any type of container over 6 pounds but not over 20 pounds net weight.	200 or less	201–800	801–1,600	1,601–3,200	3,201–8,000	8,001–16,000	16,001–24,000	24,001–32,000	Over 32,000
GROUP 4 Any type of container over 20 pounds but not over 100 pounds net weight.	48 or less	49–400	401–1,200	1,201–2,000	2,001–2,800	2,801–6,000	6,001–9,600	9,601–15,000	Over 15,000
GROUP 5 Any type of container over 100 pounds net weight.	16 or less	17–80	81–200	201–400	401–800	801–1,200	1,201–2,000	2,001–3,200	Over 3,200
Single sampling plans [1]									
Sample size (number of sample units)[2]	3	6	13	21	29	38	48	60	72
Acceptance number	0	1	2	3	4	5	6	7	8

[1] For extension of the single sample sizes beyond 72 sample units, refer to table VI of this section; for multiple sampling plans comparable to the various single sampling plans refer to table VII of this section.

[2] The sample units for the various container size groups are as follows: Group 1—1 container and its entire contents. Groups 2, 3, 4, and 5—1 container and its entire contents or a smaller sample unit when determined by the inspector to be adequate.

TABLE 5
Dried fruit

Container size group	Lot size (number of containers)								
GROUP 1 Any type of container of 1 pound or less net weight.	2,400 or less	2,401–12,000	12,001–24,000	24,001–48,000	48,001–72,000	72,001–108,000	108,001–168,000	168,001–240,000	Over 240,000
GROUP 2 Any type of container over 1 pound but not over 5 pounds net weight.	1,800 or less	1,801–8,400	8,401–18,000	18,001–36,000	36,001–60,000	60,001–96,000	96,001–132,000	132,001–168,000	Over 168,000
GROUP 3 Any type of container over 5 pounds but less than 20 pounds net weight.	400 or less	401–1,600	1,601–4,800	4,801–9,600	9,601–18,000	18,001–36,000	36,001–54,000	54,001–84,000	Over 84,000
GROUP 4 Any type of container equal to or exceeding 20 pounds but not over 100 pounds net weight.	100 or less	101–600	601–1,200	1,201–2,000	2,001–2,800	2,801–6,000	6,001–9,600	9,601–15,000	Over 15,000
GROUP 5 Any type of container over 100 pounds net weight.	25 or less	26–80	81–200	201–400	401–800	801–1,200	1,201–2,000	2,001–3,200	Over 3,200
Single sampling plans [1]									
Sample size (number of sample units.) [2] [3]	3	6	13	21	29	38	48	60	72
Acceptance number	0	1	2	3	4	5	6	7	8

[1] For extension of the single sample sizes beyond 72 sample units, refer to table VI of this section; for multiple sampling plans comparable to the various single sampling plans refer to table VII of this section.

[2] The sample units for the various container size groups are as follows: Group 1—1 container and its entire contents. Group 2—1 container and its entire contents or a smaller sample unit of 16 ounces of product or more when determined by the inspector to be adequate. Groups 3, 4, and 5—approximately 16 ounces of product. When determined by the inspector that a 16-ounce sample unit is inadequate, a larger sample unit may be substituted.

[3] In no case, shall the total of all the sample units selected yield less than 100 figs or 200 fig slices; 20 ounces of raisins; 25 ounces of dates; or 56 ounces of other dried fruit.

TABLE 6

Multiple Sampling Plans[1, 2]

Multiple sampling plans comparable to the indicated single sampling plans

| INDICATED SINGLE SAMPLING PLAN | | |

the latter circumstances one must select the total sample size that may be required for the particular multiple plan, which will always be a larger sample size than that for the comparable single plan. The actual number of sample units examined, however, may be less. The OC curves for the multiple plans are not presented here, since they are approximately equivalent to the curves in Figure 3 for the comparable single sampling plans.

Table 7 lists the average sample numbers for the multiple plans of Table 6 opposite the required sample size for the comparable single sampling plan. For example, when 38 sample units are needed for the single, an average of 15.7 sample units will be needed for multiple with lots containing 1% deviant product.

The Branch will continue to study sampling and inspection procedures with the intention of making improvements wherever desirable and practical.

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Control of Moisture in Granular Products

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(Manuscript received May 15, 1957)

For many years, the electrical resistance principle for conductivity measurement has been used effectively to determine moisture content of materials such as paper and textiles. Since these materials are in sheet form of uniform thickness, they are readily amenable to a standardized procedure.

The ability of any product to conduct electricity depends on many factors—on moisture content, mineral content, the degree to which it is compressed or compacted, the interstices between particles, pH, the amount of electrolytic salts dissolved in process water, and probably by the amount of water of composition which may be bound in its molecular structure. However, under given processing conditions on a specific product, all of these factors seem to remain relatively constant with the exception of moisture content. Hence, measurement of electrical conductivity bears a close relationship to moisture content. Repeated checks of this continuous measurement in the case of both cotton seed meats and cotton seed meal have shown consistent accuracy within 0.5%, plus or minus, of the values determined by accepted laboratory procedures.

In many production operations moisture content is a troublesome variable. Its proper adjustment is essential to efficient and effective processing of products wherein moisture must be controlled within narrow limits. One such product, and the one to which this method of moisture control was first successfully applied, is cotton seed meats.

[a] Presented at the Seventeenth Annual Meeting of the Institute of Food Technologists, Pittsburgh, Penna. May 15, 1957.

Cotton seed, essentially a grain, is processed for its oil and for its meal, an excellent constituent for animal feeds. Processing involves the addition of the proper amount of moisture, cooking to break down cell structure, and crushing to expel its oil content. Moisture content is of critical importance because, when not properly adjusted, yield of oil is poor, excess oil remains in the meal, and process equipment all down the line operates at reduced throughput and reduced efficiency. Because this operation is typical and procedures and difficulties of similar nature are found in many other processing operations, an outline of the difficulties encountered will be instructive.

ADJUSTMENT OF MOISTURE CONTENT—A TYPICAL PROBLEM

To operate efficiently, moisture content of cotton seed meats must be adjusted to within a rather narrow range. This requires the addition of moisture to meats which have been stored in a dry condition following the ginning operation.

Whether the meats are too dry or too moist, there is a considerable loss in yield of valuable oil. In addition, when moisture content is too low it is difficult to extract the oil and the meats must be cooked to the danger of excess. If the limits of cooking are exceeded, pigment in the meats will color the oil and thus render it unmarketable. Meats of low moisture content, on reaching the expeller, shatter, causing powdery wastes which are not only lost but also ne-

cessitate frequent shutdowns to permit flushing away the dusty particles.

When moisture content of the cotton seed meats is too high, processing presents another series of difficulties. Conveying becomes a problem because meats that are too moist tend to clog conveyor lines. Shutdown of production is therefore necessary to clear these stoppages. About 20% of the protein in the meats is water soluble. Excess moisture in the meats causes these proteins to dissolve, and they are lost in the cooking operation. Since protein is the valuable constituent in the meal used for animal and stock feeds, any loss of this nutritive reduces the value of and income from the meal. Naturally, too much moisture requires more cooking. Extra care in the cooking operation is also required—and close watching by plant personnel takes time away from other tasks. Additional cooking has two other economic disadvantages. Obviously, more fuel is required to supply the cooking medium for the longer "cooks." It is also apparent that the longer cooking period adversely affects the amount of throughput, thus reducing production.

It is highly desirable and economically important, therefore, to add the correct amount of moisture to cottonseed meats to improve production, to increase yield, and to assure the maximum quality for both oil and meal. This principle applies equally to many other processing operations.

SOLVING THE PROBLEM

One processor of cotton seed has met and solved the problem of moisture content control. The meats are conveyed en route to the cookers and expellers through a multi-pass screw conveyor as shown in Figure 1. Meats are subjected to water spray in the first and second passes at the top of the conveyor. Subsequent conveying is for the double purpose of mixing, so that all of the product is wetted, and of providing the necessary time interval for water absorption by the seed meats. This moisture-adding device was especially designed in the plant for the purpose. It is supplied with a constant flow of product. The device is operated at a constant speed by means of pulleys and a gear train to keep all screws in synchronism. The flights of the screws are a maximum 9 in. in diameter and are encased in a 10 in. diameter sheet metal tube so that there is ½ in. clearance between motivating screw and housing. This arrangement of moistening equipment is particularly adapted to the type of control applied because it inherently provides conditions desirable for conductivity measurements. These conditions require a uniform flow of product past the moisture adding spray nozzles, and similarly past the sensing probe. The conveyor, by its nature, will compact the product with a reasonably uniform degree of effect. There is little possibility that the probe will be sensing anything but a relatively uniform field of product. If there were void spaces in product flow or if the product were packed extremely loose or tight at intervals, it is apparent that measurement would be erratic and meaningless. In that case, since current is always trying to flow and conductivity is affected by so many factors of which moisture content is only one, there would be great variations in readings if product passing the probe were not packed in the space with some degree of uniformity.

Figure 1. Multi-pass screw conveyor.

It is fortunate that in this operation the equipment is inherently of such a nature that these conditions are met. In considering the application of this system to any product it is essential that means of meeting these conditions be provided in the event they are not intrinsically a part of the system. It may be necessary in some instances to replace existing equipment with a type similar to that outlined here so that these conditions will prevail.

Figure 2 shows the way in which the probe is mounted at the outlet end of the final pass of the conveyor. The probe itself is an insulated conductor which carries a small electrical current into the product. The shell of the conveyor is grounded to complete an electrical circuit. Of course, for current to

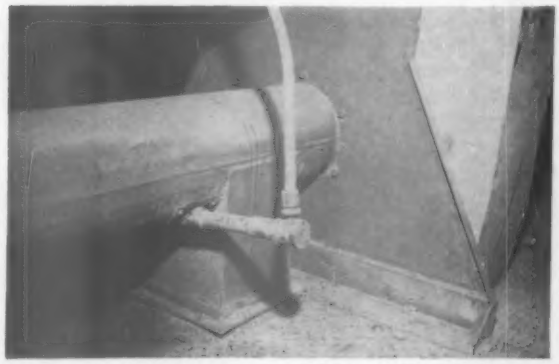

Figure 2. Showing the probe mounted at the outlet of the final pass.

flow, it must pass through the product. Since the cotton seed meats are essentially nonconductors, the amount of resistance to current flow will depend on how much moisture is in the meats.

Measurement of the amount of current flow is one of the functions of the instrument (Figure 3) known as a Moist-O-Graph controller. The measuring circuit in the instrument is a "continuous balance," Wheatstone bridge. The unknown electrical resistance of the cottonseed meats passing the probe forms one leg of this bridge.

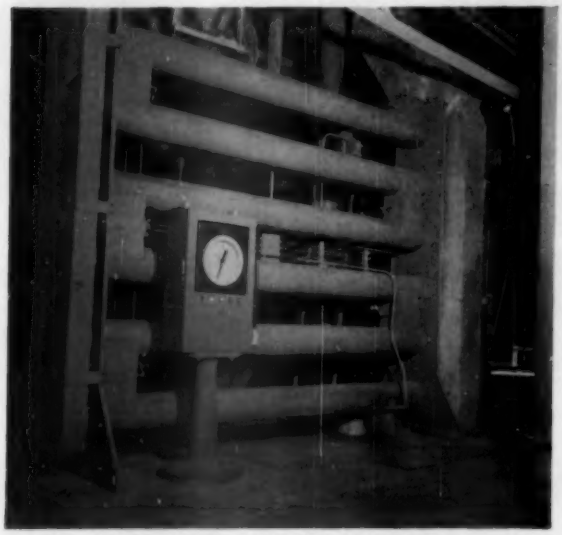

Figure 3. The Moist-O-Graph controller.

Any change across this leg of the bridge causes a momentary unbalance. This starts the balancing motor which moves a contactor across a slidewire resistor until the bridge is again balanced. The indicating pointer and recording pen are connected to the balancing motor. Thus, they will indicate and record variations in measurement.

Movement of the mechanism also causes the control action which adjusts the opening of the control valve to supply more or less water.

Figure 4 visualizes the control valve in the pipe line which supplies water for moistening cotton seed meats. In this instance a self-contained electrically operated floating control valve is the final control element. Either electric control, as shown in Figure 4, or proportioning pneumatic control is available. Local conditions in the plant determine the selection of the type to be used. This flexibility makes the selection of ideal equipment very simple.

Figure 5 shows the results of a typical day's operation. Note that the chart calibration is an arbitrary 0–100. This can equally well be calibrated in percentage of moisture although this would require on-the-job calibration because of the different values for various products. It would be likely to vary for the same product in plants located in different parts of the country. The significant point,

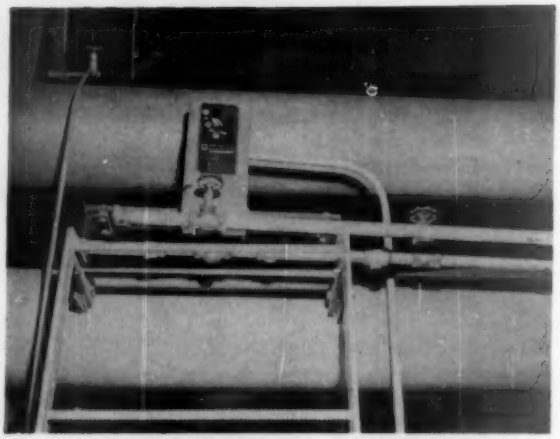

Figure 4. Control valve governing water supply for moistening cotton seed meats.

however, is that results are reproducible; the widest variations as found by careful laboratory moisture determinations was a maximum variation of ± 1% when the process was on control. Such a variation is well within tolerable limits for this operation. There is little doubt that even closer control can be obtained by the method if this is essential for any other product application.

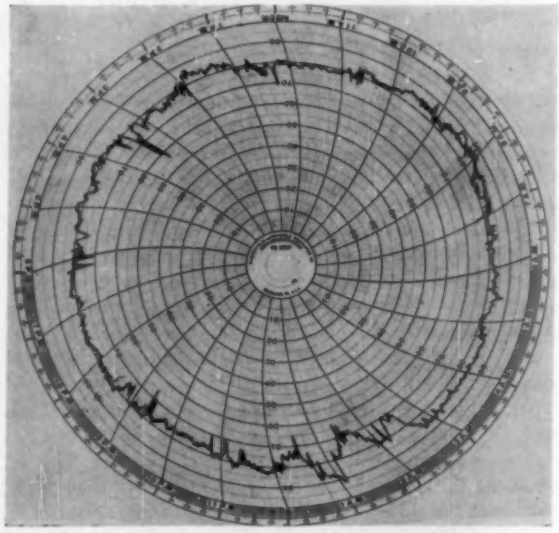

Figure 5. Record of a typical day's operation.

THE COMPLETE SYSTEM

The complete system is shown in diagram (Figure 6) to indicate the component parts of the control system and the location of elements in the production flow line. Moisture is measured as product is leaving the screw conveyor. Product has previously been treated to add moisture and the time element for proper absorption has been provided. Now, if the instrument measures a low moisture content, the valve is automatically adjusted to increase the

amount of water applied. Conversely, if moisture readings are high, the amount of water applied is reduced.

This is an example of the exploration of the application of known methods to products on which it had not been applied previously. There are many factors in this method of moisture measurement that would tend to restrain the timid. These factors apply almost equally to the measurement of moisture in products of sheet form, and yet the method is widely accepted and has been used for many years. By eliminating as many unknown elements as possible and by using care to control such factors as

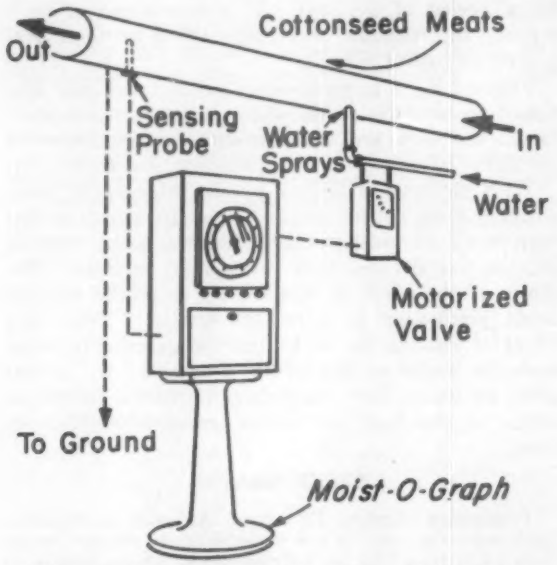

Figure 6. The component parts of the control system.

compactness of material, location of sensing element, and method of adding moisture, results exceed expectations.

The installation which forms the basis of this report has operated through two seasons. Plant management, in anticipation of benefits promised by successful control, lent all possible co-operation to the project. Results have shown that the control system is reliable and accurate—in short, an excellent investment.

Following this successful installation plant management reasoned that the same system would provide a reliable means of controlling moisture content of finished cotton seed meal. Regulations limit the allowable moisture content of meal. This means that without an accurate and reliable means of control, moisture content of meal would have to be held well below the allowable content to be certain that the plant adhered to the regulations.

A second installation was made in the same plant. This time the product was finished meal. Equal consideration was given to all the significant known variables and equipment adapted to meet the conditions as found to be important in the experience gained in the first application.

Again the results exceeded expectations. The cotton seed meal moisture control system has operated through a complete processing season. Management at the plant is enthusiastic in its praise of the results. It is possible to comply with the regulations regarding product moisture content without the fear of exceeding the legal limits. Reports from this installation indicate that an accuracy throughout the season was maintained at 0.5%.

INSTANTANEOUS CONTROL OF A TROUBLESOME VARIABLE

Indications are that this principle will provide the means for moisture control of any grain product. The possibilities are great that successful use of the continuous control of moisture in many granular products can also be accomplished. It is of course important to study present methods of accomplishing moisture adjustment. Usually, with slight modification, operations can be set up to eliminate or at least to hold within close limits those variable conditions which would adversely affect this control system.

Here then is another technique for the food technologist to apply to an important production problem. Successfully applied, this method transforms a costly time-consuming laboratory check of a process operation into an instantaneous continuous control of another process variable. The technique, in addition to all its other advantages, applies correction when and as needed in the process stream as opposed to accepted methods which reveal errors much too late to apply corrective measures.

Vitamin K_5 as a Preservative for Wine[a, b, c]

(Manuscript received May 13, 1957)

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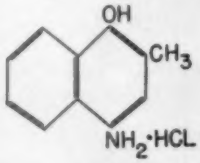
At the present time sulfur dioxide is the only preservative legally permitted in wine. In its use, however, many disadvantages are encountered, and the search for a better preservative is universal. The most serious disadvantages are the development of undesirable flavor, its interference with proper aging, and to a lesser extent, the formation of precipitates and turbidities *(1, 4, 7, 16)*.

In recent years, several new chemicals and antibiotics with very low toxicity and high microbicidal power have been developed and some have been successfully used for food preservation. One of these chemicals, an analog of vitamin K, vitamin K_5 (2-methyl-4-amino-1-naphthol hydrochloride) with the following structure *(14)*, was found by Pratt *et al.*



(8) to exhibit a marked inhibitory activity toward a number of microorganisms including *Saccharomyces cerevisiae*, the common brewer's yeast.

The term vitamin K, derived from the German and Scandinavian expression "Koagulations-Vitamin," has been applied to the compound recognized by Dam *(5)* in 1929 as one which would decrease blood clotting time. The K vitamins are found in the green leaves, as of alfalfa, spinach, kale, and others, as well as in cheese, egg yolk, liver, and tomatoes.

Shartzman *(11)* showed that vitamin K_5 possesses marked antibacterial action against Gram-positive and Gram-negative microorganisms. Verona *(15)* found vitamin K_5 and K_3 to possess antibiotic powers at concentrations ranging from 0.05 to 0.005% when used on many different yeasts grown in a synthetic medium.

In studying vitamin K_5 as a food preservative, Faggioli *(6)* found a 0.1% concentration of vitamin K_5 had the inhibitory effect of 1% salicylic acid. A concentration of 20 p.p.m. was an effective preservative agent for soy sauce, report two Japanese workers *(12)*. Tengerdy and Francia *(13)* found that vitamin K_5 at a concentration of 0.6 g. to 1.0 g./l. did not change the taste or produce any toxic effects when used as a beer preservative. Ribereau-Gayon and Peynaud *(10)* found that concentrations of 5 mg. to 300 mg./l. delayed onset of fermentation in grape musts. Athanassiadis, Caspar, and Yang *(3)* found that 8 p.p.m. of vitamin K_5 would completely inhibit secondary fermentation in light sweet wine for a period of 30 days. At a concentration of 7 p.p.m., the vitamin was more effective than 200 p.p.m. of sulfur dioxide.

Vitamin K_5 is a water soluble compound that was found to be very stable when protected from sunlight. It has a low toxicity and did not influence the flavor of any product to which it was added *(9)*.

With the hope of finding a wine preservative more suitable than sulfur dioxide, this investigation has been made to evaluate the effectiveness of vitamin K_5. It was divided into three main sections: The study of the effect of vitamin K_5 to inhibit volatile acids production in wine, the study of inhibitory effect of vitamin K_5 on the microorganisms in wine, and the study of the effect of vitamin K_5 on the color of wine. For comparison purposes, sulfur dioxide in the form of potassium metabisulfite was used.

EXPERIMENTAL

Preparation of wine. Throughout the entire investigation, apple wine was used. It was prepared in the regular manner from apple juice with the addition of commercial dextrose to obtain a wine of 11–12% alcohol by volume which is referred to as high alcohol wine in this article. The wine was not pasteurized and no chemicals were added. The analysis for this wine appears in Table 1.

TABLE 1

Analysis of High Alcohol Wine

Percent alcohol by volume	11.7
Total acids as tartaric g./100 ml.	0.568
Volatile acids as acetic g./100 ml.	0.060
Degrees brix at 20°/20°C.	−1.8
Specific gravity at 20°/20°C.	0.9932
pH	3.4

Wines made for subsequent experiments were of similar analyses, except for volatile acids studies on low alcohol wine in which the apple juice was fermented without the addition of yeast cultures and sugar. The analysis for the low alcohol wine appears in Table 2.

Volatile acids study. Four-fifth quart bottles with screw caps were used to hold the wine. Three bottles for each concentration of the preservatives were used. All bottles were stored at room temperature, with the caps loosely fitted. Samples were taken from all 3 bottles at different time intervals and analyzed for total volatile acids content. Macroscopic growth that began to appear at 120 days was observed and recorded.

Total volatile acids content in all cases was determined by steam distillation according to the procedure described by the Association of Official Agricultural Chemists *(2)*.

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[a] Approved for publication by the Director of the Oregon Agricultural Experiment Station as Technical paper No. 1064. Contribution of the Department of Food and Dairy Technology.

[b] Based on a thesis by J. N. Caspar, submitted in partial fulfillment of the Master of Science degree.

[c] Presented before the 17th Annual Meeting of the Institute of Food Technologists, Pittsburgh, Pa., May 13, 1957.

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Plate count study. Five percent by weight of dry commercial sucrose was added to the wine to promote additional microorganism growth. Half-pint bottles with cotton plugs were autoclaved. Wine was pipetted into them, and different concentrations of preservatives were added. All bottles were incubated at 28°C. Samples were removed at different time intervals and serial dilutions made from which duplicate plat-

TABLE 2

Analysis of Low Alcohol Wine

Percent alcohol by volume	7.1
Total acids as tartaric g./100 ml.	0.563
Volatile acids as acetic g./100 ml.	0.063
Degrees brix at 20°/20°C.	−0.2
Specific gravity at 20°/20°C.	0.9993
pH	3.6

ings were poured for incubation at 30°C. A dextrose-peptone agar media, with the pH adjusted to 3.6 by addition of a 15% tartaric acid solution, was used in all plates. All plates were counted after 48 hours of incubation.

Color study. The apple wine was pipetted into 4/5 quart bottles and the preservatives added. Two sets of samples were used—one set was analyzed after one month while the other set was analyzed after 5 months' storage at room temperature. At the end of these storage periods, samples were removed and the extinction coefficient read on a Beckman Quartz Model DU Spectrophotometer at 25 mμ wave length gradations from 400–625 mμ.

RESULTS AND DISCUSSION

Results obtained from the volatile acids studies (Tables 3, 4, 5, Figures 1, 2) are all arithmetic means of 3 determinations and in all cases the total of volatile acids is expressed as acetic acid. Volatile acids production inhibition in per cent was calculated according to the following formula:

$$q = \frac{a - b}{a} \times 100,$$

where "q" is the volatile acids production inhibition in per cent, *a* is the volatile acids produced in the control sample, and *b* is the volatile acids produced in the sample containing the preservative.

In the high alcohol wine, the lowest concentration of vitamin K_5 attaining 100% inhibition at 30 days was 80 p.p.m.; at 60 and 90 days it was 100 p.p.m.; at 120 days it was 200 p.p.m. The lowest concention of sulfur dioxide attaining 100% inhibition at these different time levels was 300 p.p.m. In comparison, 60, 80, and 100 p.p.m. of the vitamin was as effective as 100, 200, and 300 p.p.m. of sulfur dioxide, respectively.

In the low alcohol wine, 100% inhibition was attained with 80 p.p.m. of the vitamin at the 15-day

TABLE 3

Volatile acids production and inhibition in high alcohol wine

Preservative and Concentrations	Gm./100 ml.							
	30 days	"q"	60 days	"q"	90 days	"q"	120 days	"q"
Vitamin K_5								
20 ppm	0.022	45.0	0.058	21.6	0.088	24.1	0.112	24.3
40 ppm	0.004	90.0	0.024	67.6	0.070	39.7	0.094	36.5
60 ppm	0.002	95.0	0.010	86.5	0.034	70.7	0.058	60.8
80 ppm	0.000	100.0	0.003	96.0	0.009	92.2	0.024	83.8
100 ppm	0.000	100.0	0.000	100.0	0.000	100.0	0.003	98.0
200 ppm	0.000	100.0	0.000	100.0	0.000	100.0	0.000	100.0
Sulfur Dioxide								
100 ppm	0.018	30.0	0.046	37.8	0.064	44.8	0.090	39.2
200 ppm	0.006	85.0	0.09	87.8	0.012	94.5	0.022	85.1
300 ppm	0.000	100.0	0.000	100.0	0.000	100.0	0.000	100.0
Control	0.040	0.0	0.074	0.0	0.116	0.0	0.148	0.0

TABLE 4

Volatile acids production in low alcohol wine

Preservative and Concentrations	Gm./100 ml.										
	Days Storage										
	2	4	6	8	10	13	15	17	21	25	30
Vitamin K_5											
10 ppm	0.000	0.012	0.024	0.042	0.060	0.087	0.108	0.144	0.204	0.246	0.300
20 ppm	0.000	0.000	0.006	0.018	0.024	0.052	0.088	0.111	0.170	0.230	0.266
30 ppm	0.000	0.000	0.003	0.006	0.021	0.030	0.069	0.086	0.145	0.208	0.252
40 ppm	0.000	0.000	0.000	0.006	0.020	0.024	0.042	0.075	0.130	0.165	0.174
50 ppm	0.000	0.000	0.000	0.000	0.003	0.015	0.036	0.066	0.123	0.153	0.165
60 ppm	0.000	0.000	0.000	0.002	0.002	0.006	0.009	0.015	0.036	0.060	0.093
70 ppm	0.000	0.000	0.000	0.000	0.000	0.003	0.009	0.012	0.024	0.036	0.054
80 ppm	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.012	0.021	0.036
90 ppm	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.006	0.012
100 ppm	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.003	0.003
Sulfur Dioxide											
100 ppm	0.000	0.006	0.015	0.036	0.066	0.090	0.111	0.138	0.168	0.222	0.258
200 ppm	0.000	0.000	0.006	0.009	0.015	0.036	0.054	0.087	0.135	0.168	0.180
300 ppm	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.003	0.006	0.006
Control	0.006	0.024	0.096	0.120	0.144	0.156	0.180	0.216	0.312	0.384	0.432

TABLE 5

Per cent volatile acids production inhibition in low alcohol wine

Preservative and Concentrations	Gm./100 ml.										
	Days, Storage										
	2	4	6	8	10	13	15	17	21	25	30
Vitamin K_5											
10 ppm	100.0	50.0	75.0	68.3	58.3	44.2	40.0	33.3	34.6	35.9	30.6
20 ppm	100.0	100.0	93.8	85.0	83.3	66.7	51.1	48.6	45.6	40.1	38.4
30 ppm	100.0	100.0	96.9	95.0	85.4	80.8	66.7	60.2	53.5	70.8	41.7
40 ppm	100.0	100.0	100.0	95.0	86.1	84.6	76.7	65.3	58.3	75.7	59.7
50 ppm	100.0	100.0	100.0	100.0	97.9	90.4	80.0	69.4	60.6	60.2	61.8
60 ppm	100.0	100.0	100.0	98.3	98.6	96.2	95.0	93.1	88.5	84.4	78.5
70 ppm	100.0	100.0	100.0	100.0	100.0	98.1	95.0	94.4	92.3	90.6	87.5
80 ppm	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.6	96.2	94.5	91.7
90 ppm	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.0	98.4	97.2
100 ppm	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.4	99.2	99.3
Sulfur Dioxide											
100 ppm	100.0	75.0	84.4	70.0	54.2	42.3	38.3	36.1	46.2	42.2	40.3
200 ppm	100.0	100.0	93.8	92.5	89.6	76.9	70.0	59.7	56.7	56.3	81.5
300 ppm	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.1	99.0	98.4	98.6
Control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

level, while 100 p.p.m. showed 99.3% at the 30-day level. Sulfur dioxide obtained 100% inhibition at the 2-day level with 200 p.p.m., while this inhibition was attained at the 15-day level with 300 p.p.m.

The amount of macroscopic growth observed on the surface of the high alcohol wine after 120 days appears in Table 6. Results show that no growth was observed at the lowest concentration, 20 p.p.m., of vitamin K_5. This was true for all vitamin K_5 samples and thus the higher concentrations, 70, 80, 90, and 100 p.p.m., are omitted from the table.

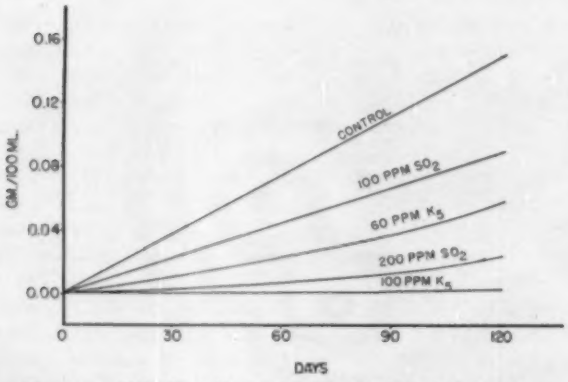

Figure 1. Volatile acids production in high alcohol wine.

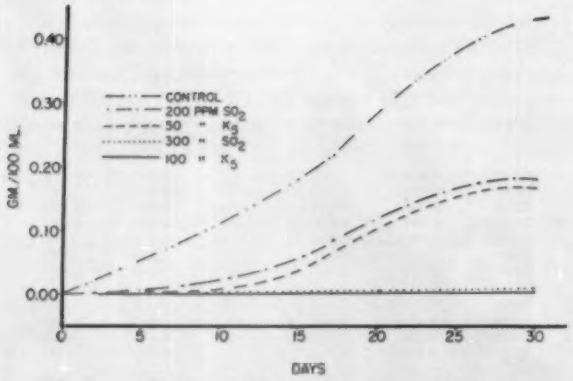

Figure 2. Volatile acids production in low alcohol wine.

TABLE 6

Macroscopic surface growth in wine

Preservative and Concentration	Amount of Growth[1]					
	135 Days	150 Days	165 Days	180 Days	195 Days	210 Days
Vitamin K_5						
20 ppm	—	—	—	—	—	—
40 ppm	—	—	—	—	—	—
60 ppm	—	—	—	—	—	—
Sulfur Dioxide						
100 ppm	†	†	††	††	†††	†††
200 ppm	—	†	†	††	††	†††
300 ppm	—	—	†	†	††	†††
Control	†	††	††	†††	†††	†††

[1]Legend:
— No Growth
† Slight Growth
†† Moderate Growth
††† Heavy Growth

Sulfur dioxide showed a distinct inhibitory effect as the concentration increased from 100 to 300 p.p.m. However, at the 210-day level, the majority of the sulfur dioxide samples contained heavy growth. The control showed heavy growth at the 150-day level.

Of the total number of colonies developing per ml. of wine upon plating, the increase or decrease in relation to the initial count was calculated and appears in Figure 3.

Results show that all concentrations of vitamin K_5 used produced a 100% decrease in the number of colonies. At a concentration of 10 p.p.m. the vitamin showed this decrease at the 4-day level, while this decrease was obtained at the 1- and 2-day levels with 40 and 20 p.p.m., respectively. Sulfur dioxide showed a 100% decrease at the 300 p.p.m. concentration, which was obtained at the 1-day level. In comparing the two preservatives, 10 p.p.m. of the vitamin proved more effective than did 100 and 200 p.p.m. of sulfur dioxide, while 40 p.p.m. was as effective as 300 p.p.m. of sulfur dioxide.

The extinction coefficient, or E value, for the different concentration levels of preservatives appears

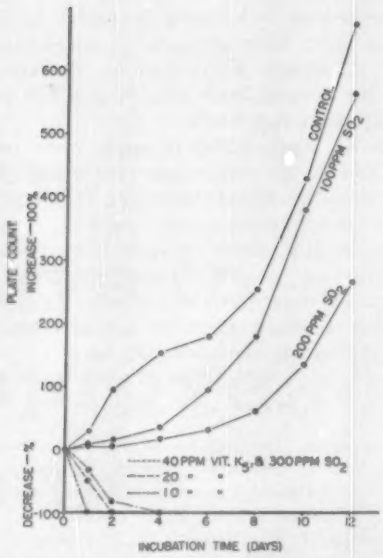

Figure 3. Plate counts of light sweet wine.

in Tables 7, 8, and Figures 4, 5. The results for the wine stored for one month show that vitamin K_5 had a pronounced darkening effect while sulfur dioxide had a bleaching effect. This was especially shown at the shorter wave lengths. At 400 mμ, the E value for the control was 0.606, while for the 100 p.p.m. concentration of the vitamin and sulfur dioxide it was 1.16 and 0.452, respectively. As the concentration of sulfur dioxide increased from 100 to 200 p.p.m. there was not an appreciable difference here in bleaching action. Vitamin K_5, likewise, did not show any appreciable darkening effect when the concentration increased from 100 to 200 p.p.m.

In the wine with five months' storage, as in the wine with one month storage, the vitamin K_5 samples possessed a darker color. This again was most noticeable at the shorter wave lengths. At 400 mμ the E value for the control sample was 0.296, while

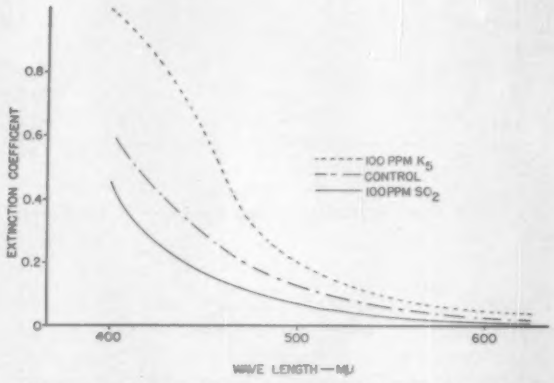

Figure 4. Spectrophotometric characteristics of apple wine (after one month).

TABLE 7

Spectrophotometric characteristics of apple wine after one month of storage

Preservative and Concentration	Extinction Coefficient									
	Wave Length-Millimicrons									
	400	425	450	475	500	525	550	575	600	625
Vitamin K_5										
10 ppm	0.878	0.692	0.497	0.246	0.130	0.081	0.052	0.031	0.021	0.013
50 ppm	1.080	0.900	0.623	0.308	0.165	0.105	0.074	0.031	0.037	0.027
100 ppm	1.160	0.845	0.602	0.318	0.178	0.120	0.085	0.061	0.046	0.037
200 ppm	1.160	0.895	0.658	0.328	0.182	0.124	0.090	0.065	0.051	0.044
Sulfur Dioxide										
100 ppm	0.452	0.260	0.169	0.112	0.073	0.047	0.030	0.016	0.012	0.009
200 ppm	0.434	0.255	0.154	0.100	0.164	0.040	0.025	0.016	0.012	0.009
300 ppm	0.457	0.254	0.166	0.122	0.077	0.051	0.038	0.027	0.019	0.018
Control	0.606	0.424	0.294	0.177	0.108	0.070	0.046	0.031	0.019	0.013

TABLE 8

Spectrophotometric characteristics of apple wine after five months' storage

Preservative and Concentration	Extinction Coefficient									
	Wave Length-Millimicrons									
	400	425	450	475	500	525	550	575	600	625
Vitamin K_5										
10 ppm	0.559	0.442	0.315	0.152	0.083	0.057	0.024	0.033	0.023	0.017
30 ppm	0.573	0.452	0.317	0.148	0.078	0.050	0.030	0.028	0.020	0.014
50 ppm	0.628	0.498	0.354	0.179	0.103	0.074	0.056	0.049	0.039	0.034
80 ppm	0.609	0.467	0.319	0.155	0.082	0.054	0.038	0.028	0.017	0.015
100 ppm	0.635	0.476	0.324	0.161	0.087	0.058	0.024	0.029	0.018	0.018
Sulfur Dioxide										
100 ppm	0.230	0.143	0.105	0.079	0.016	0.047	0.039	0.035	0.031	0.027
200 ppm	0.199	0.114	0.077	0.051	0.034	0.023	0.017	0.013	0.012	0.011
300 ppm	0.203	0.117	0.077	0.052	0.036	0.024	0.019	0.015	0.012	0.111
Control	0.296	0.198	0.142	0.099	0.073	0.057	0.046	0.039	0.030	0.029

for the 100 p.p.m. concentration of the vitamin and sulfur dioxide it was 0.635 and 0.203, respectively. The effect of bleaching or darkening was not as noticeable as it was in the wine stored for one month. This was shown by smaller differences in E values.

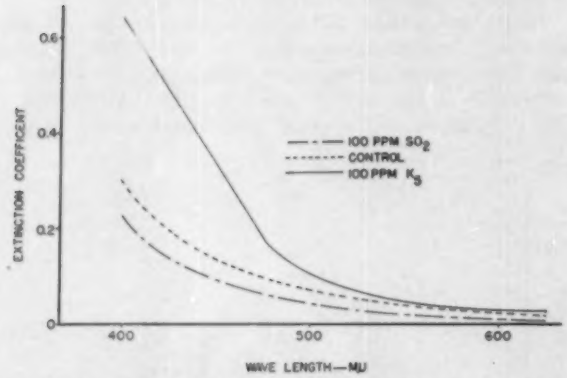

Figure 5. Spectrophotometric characteristics of apple wine (after 5 months).

Here the control appeared lighter, which seemed to indicate that the wine had bleached during storage.

By visual inspection, in both wines, the vitamin K_5 samples possessed a much darker and richer color than did either the control or sulfur dioxide samples, while the control possessed a more acceptable color than did the latter. These results would indicate that the use of vitamin K_5 for use as a preservative would be beneficial in wines, such as apple, that lack appeal due to their pale appearance. However, in wines where bleaching is desirable, such as sauterne and some other white wines, the addition of vitamin K_5 would prove harmful.

SUMMARY AND CONCLUSION

Sulfur dioxide has been used as a chemical preservative for wine for many years. At the present time, it is still the only legal preservative for wine. Use of sulfur dioxide, however, results in many disadvantages such as the development of undesirable flavor, interference with aging, and the formation of precipitates and turbidity.

Previous investigation by the authors showed that at 7 p.p.m., vitamin K_5 is effective in preventing secondary fermentation in light sweet wines.

Present work was done using vitamin K_5 as preservative in controlling the development of volatile acids. Results showed that vitamin K_5 was more effective than sulfur dioxide in inhibiting volatile acids production. At a concentration of 30 p.p.m., vitamin K_5 was more effective than 100 p.p.m. of sulfur dioxide.

All concentrations of vitamin K_5 (i.e. 10, 20, and 40 p.p.m.) showed a 100 per cent decrease of colonies of microorganisms developing in plates made from light sweet apple wine samples. A concentration of 40 p.p.m. of vitamin K_5 proved as effective as 300 p.p.m. sulfur dioxide, both obtaining a 100 per cent decrease at the 1-day level.

Vitamin K_5, when added to apple wine, produced a darker and richer color than was observed in the control and sulfur dioxide samples. This was true in both the 1- and 5-month storage periods.

Throughout this entire investigation, vitamin K_5, disregarding cost, proved superior to sulfur dioxide in all ways. It imparted a richer color to apple wine and showed a much stronger antimicrobial power when compared on concentration basis.

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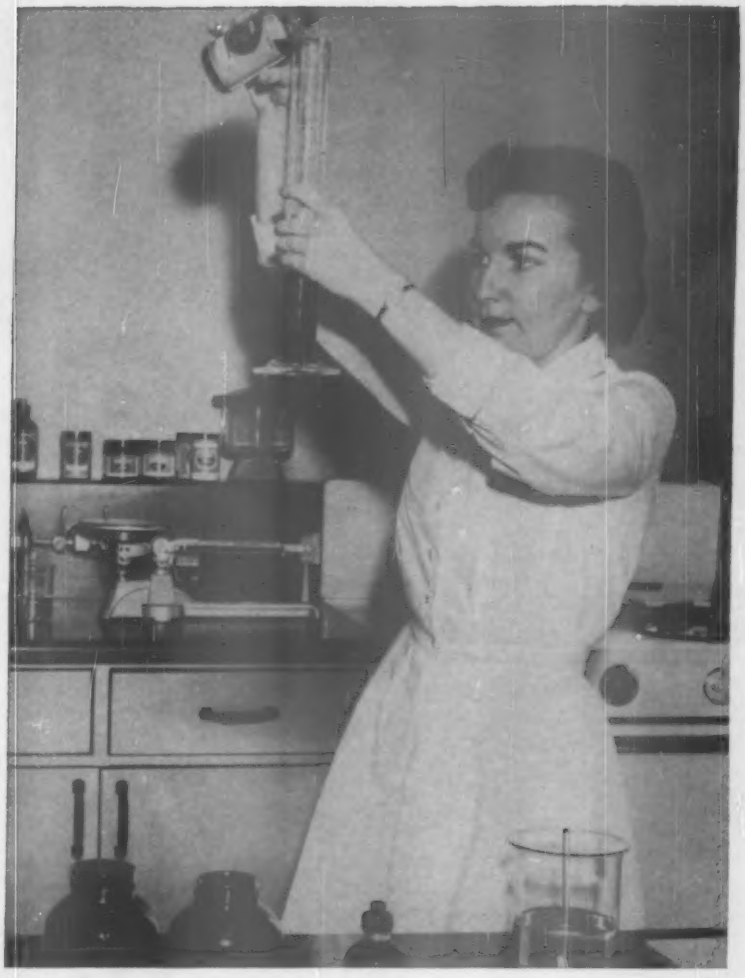

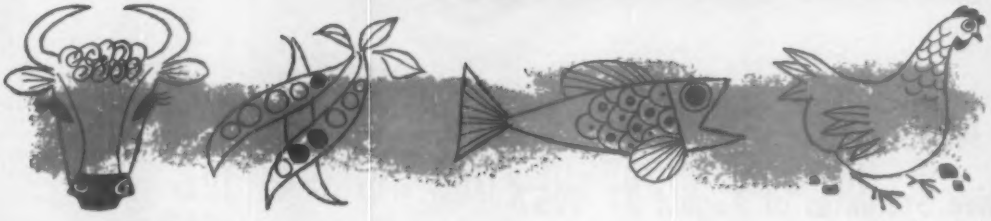

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Of Professional Interest

(Continued from page 34 preceding technical papers)

Food Engineering or Food Science. Awards shall be made to deserving and outstanding United States or Canadian citizens of at least second year standing in recognized educational institutions in the U. S. or Canada. Not more than two of these scholarships may be held in the same school at the same time, except under unusual circumstances.

The curriculum of the Department wherein the schcolarship is to be held must be approved by the Donor. These scholarships will be continued for the second year only upon satisfactory performance by the student and recommendation of the Department Head wherein scholarship is held.

Applicants to qualify must have completed (1) 2 full years of college mathematics, (2) 2 full years of chemistry, (3) 1 full year of physics, (4) 1 full year of biological sciences, (5) at least 1 year of the humanities.

Candidates will be judged on over-all ability including scholarship, personality, extracurricular activities, social adjustment, character, etc.

PURPOSE: To encourage deserving and outstanding students to take undergraduate work leading to a Bachelor's Degree in Food Technology, Food Engineering or Food Science.

APPLICATIONS: Applications shall be in the form of a letter from the applicant giving the following personal and academic information:

Name, nationality, age, sex, marital status, physician's statement as to general health and physical condition, a small photograph of applicant.

Transcript of all college or university work already completed. (In addition to the official transcript, applicant must submit typewritten summary of transcript listing in detail subjects pursued and grades attained.)

A list of extracurricular activities.

A supporting letter from the Head of the Department wherein student is to hold the scholarship. This letter should present:

A general appraisal of applicant with particular reference to the detailed requirements listed above.

A statement that student will be accepted in his Department.

An indication of need, if any, for financial assistance.

Applications must be submitted to Executive Secretary, IFT, not later than March 1st for scholarships to begin the following September.

Recommendation from a Department Head for the continuation of a scholarship must be submitted to the Executive Secretary, IFT, 176 W. Adams St., Chicago, Ill., not later than March 1st for scholarships ending the following June.

Food Additives—

Legislative Status as of August 27, 1957

FINAL HEARINGS on food additives bills to amend the FD&C Act of 1938 are expected early in 1958, with legislative enactment to follow before the 2nd Session of the 85th Congress ends about a year from now.

Supplementing the testimony already reported in an earlier issue of Food Technology, Dr. William J. Darby, Chairman, and 14 other scientists testified before the Congressional Subcommittee on Health and Science on August 6th and 7th.

IFT President Emil M. Mrak and IFT members H. K. Murer, F. N. Peters and H. C. Spencer gave excellent scientific testimony along with that of 11 other biochemists, pharmacologists, and cancer research experts. These men emphasized the usefulness of additives, the precautions to assure safety, and the lack of evidence of harm from proper use of additives.

Rep. John Bell Williams, Subcommittee Chairman and his colleagues anticipate that FDA Commissioner Larrick and perhaps others will testify in 1958.

The complete record of the Hearing to date is open to the public at the Office of the House Interstate and Foreign Commerce Committee, Room 1334, 3rd floor, New House Office Building, South Capitol Street and Independence Avenue, SW, Washington, D. C. Copies of the official Reporter's record, about 100 pages for each of the ten days, is available at about 50c per page. The record is not likely to be Government-printed until after the hearings of 1958 are concluded.

FRANK L. GUNDERSON, Chairman
IFT Committee on Food Additives

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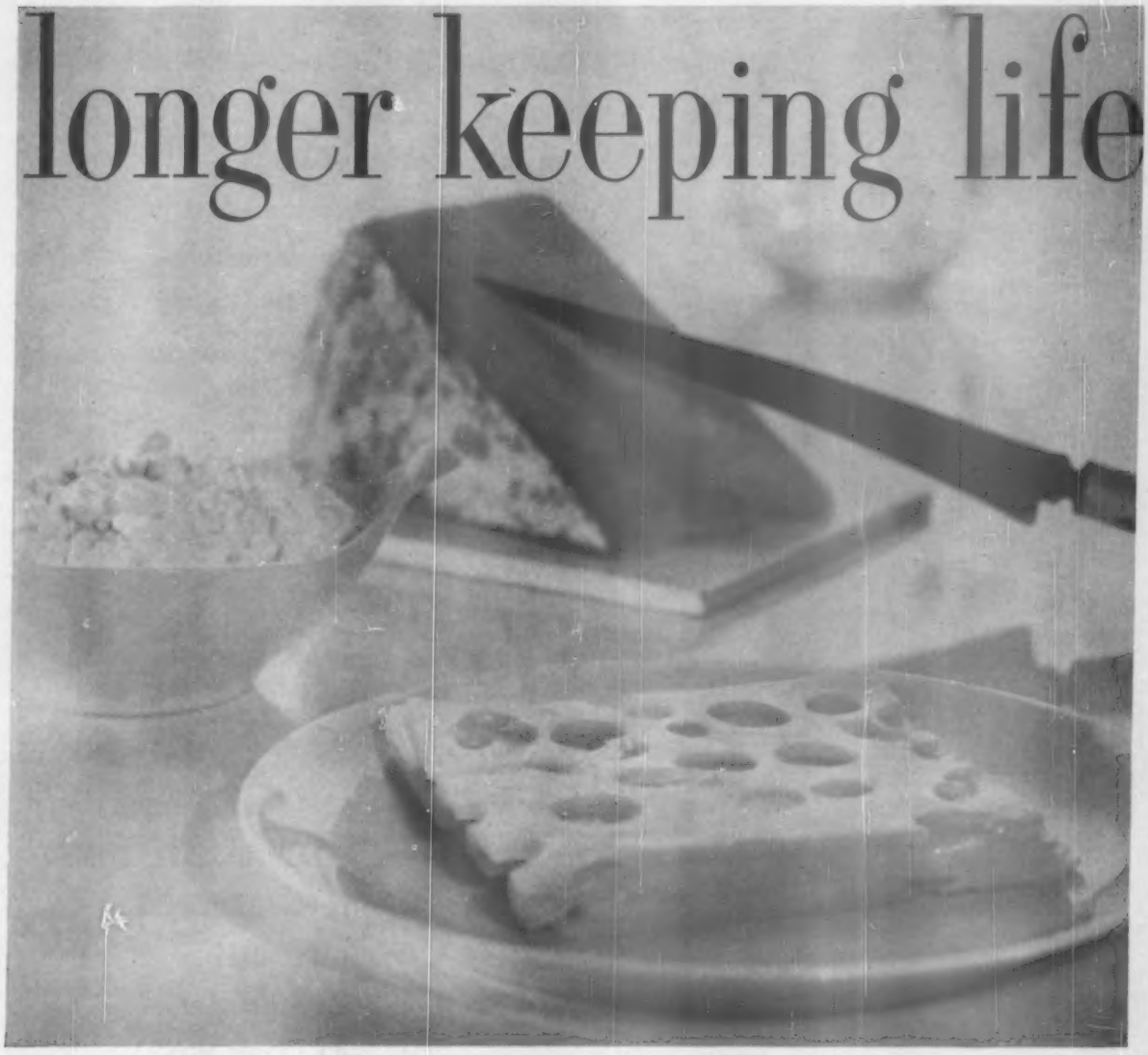

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Some Highlights of the Annual Fall Meeting of the American Oil Chemists' Society

The American Oil Chemists' Society annual fall meeting, held September 30–October 2 at the Netherland Hilton Hotel in Cincinnati, Ohio, presented a technical program of more than 50 papers. Papers on detergents and various aspects of their examination and use were presented by Edward H. Armbruster of the University of Michigan School of Public Health who discussed the "Effect of Oil Films on the Cleanliness of Surfaces"; by R. R. Suskind of the Kettering Laboratory of Applied Physiology who spoke on the "Effect of Detergents on Skin"; by J. K. Weil and colleagues of the Eastern Utilization Research and Development Division, who described "Detergent Bars from Salts of α-Sulfonated Tallow Fatty Acids"; and by J. David Justice of Lever Bros. Company who discussed "Water Supply and Sewage Treatment." The related field of measurement of color and fluorescence was treated by Richard Hunter in a paper on a "New Scale and Instrumentation for Color Measurement." A. R. Martin of the Whirlpool-Seeger Corporation, spoke on the "Use of Color Measurement in Practical Detergent Evaluation."

New information on composition and processing of natural oils was presented by C. Y. Hopkins of the National Research Council of Canada. His topic was *Kenaf Oil*. The literature and the present commercial situation regarding *Isano Oil* was also reported. Processing of oil seeds and of fats and oils were treated in several papers, including one on "Solvent Extraction of Castor Oil" by E. L. D'Aquin and others of the Southern Utilization Research and Development Division. "Long Chain Unsaturated Alcohols from Jojoba Oil by Sodium Reduction" was another paper of interest. It was given by L. J. Molaison of the same laboratory. "A Continuous Hydrogenation Process" was described by V. F. Green of the Procter and Gamble Company. "Methods for Improving Quality of Tallow and Grease," by D. S. Austin of the same company and an "Improved Ion Exchange Epoxidation Process," by J. P. Termini of the Permutit Company were additional papers in this section.

Other papers presented were the "Behavior of Distilled Monoglycerides in the Presence of Water," by George Y. Brokaw of Distillation Products Industries; "A Method of Analysis for Free Gossypol," by G. Schramm and J. H. Benedict of the Procter and Gamble Company; and "The Use of Statistical Techniques for Attaining Product Specifications" by H. Smith and T. F. Waters of the same company.

Masters and Doctors in Food Technology and Related Subjects—1957

Additional 1957 graduates in the field of food science, technology, or related subjects have come in from Pennsylvania State University at University Park. The graduates listed are from various departments of the College of Agriculture.

Name	*Degree*	*Title of Thesis*
Boyd, John E.	Ph.D.	The Use of *Daphnia magna* in the Microbioassay of Insecticides
Day, Edgar A.	Ph.D.	The Identification of Some Off-Flavored Compounds from Gamma Radiated Skimmilk
Erchegovich, Charles D.	Ph.D.	Studies on the Analysis and Persistence of 3-Amino-1,2,4-Triazole in Soils and Plant Tissues
Hartzell, Thomas H.	M.S.	The Effects of Certain Chelating and Sequestering Agents on the Chlorophyll Concentration in Canned Peas
Heck, Joseph G.	Ph.D.	Studies on Some Endocellular Peptidases of an Oxidative Type Yeast
Passananti, G. Thomas	Ph.D.	Effect of Supplementary Methionine and Choline on Tissue Lipides and on the Vascular Structure of Cholesterol-Fast Growing Rats
Perry, Alvah L.	Ph.D.	Economic Effects of Separating Maine Potatoes into Two Quality Grades
Sabry, Jean H.	Ph.D.	Human Utilization of Dehydroascorbic Acids
Sabry, Zakaria I.	Ph.D.	Retention of Certain Vitamins by Pickled Cheeses During Production and Ripening
Voth, Orville L.	Ph.D.	Studies of Intravenous Injection of Tocopherol in Chickens and of Interactions of Tocopherol with Proteins and Amino Acids
Weinbaum, George	Ph.D.	The Formation and Stability of Enzymes in *Escherichiavoli*

Colleges and Universities Offering Food Technology

A Revised List

An up-to-date list of colleges and universities offering courses in Food Technology has been submitted by Dr. Walter A. Maclinn, Rutgers University, New Brunswick, New Jersey, 1956-57 chairman of the IFT Committee on Education. The list, which follows, now numbers 24 institutions.

COLLEGES AND UNIVERSITIES OFFERING TRAINING PROGRAMS IN FOOD TECHNOLOGY (EXCLUSIVE OF DAIRY OR OTHER SPECIALIZED PROGRAMS)
September, 1957

Institution	Place	Program Location	Dept. or Group Supervising Program	Leader of Program
Agricultural & Mechanical College of Texas	College Station, Texas	Dairy	Committee	A. V. Moore
Cornell University	Ithaca, N. Y.	Dairy	Dairy	E. A. Nebeskey
Illinois Inst. of Tech.	Chicago, Illinois	Food Engineering	Food Engineering	M. E. Parker
Iowa State College	Ames, Iowa	– – –	Committee	J. C. Ayres
Massachusetts Inst. of Technology	Cambridge, Mass.	Food Technology	Food Technology	B. E. Proctor
Miami University	Coral Gables, Florida	Food Technology	Food Technology	J. A. Lewis
Michigan State University	East Lansing, Michigan	– – –	Committee	N. P. Ralston
North Carolina State College	Durham, North Carolina	Horticulture	Horticulture	I. D. Jones
Ohio State University	Columbus, Ohio	Inst. of Nutrition & Food Technology	Committee	J. B. Brown
Oregon State College	Corvallis, Oregon	Food Technology	Food Technology	H. W. Schultz
Penn. State Univ.	Univ. Park, Penn.	Horticulture	Horticulture	F. B. Thomas
Purdue University	West Lafayette, Indiana	Horticulture	Horticulture	N. W. Desrosier
Rutgers University	New Brunswick, N. J.	Food Technology	Food Technology	W. A. Maclinn
Syracuse University	Syracuse, New York	Home Economics	Committee	Jean I. Simpson
Univ. of California	Davis, California	Food Technology	Food Technology	E. M. Mrak
Univ. of Florida	Gainesville, Florida	Food Technology & Nutrition	Food Technology & Nutrition	R. A. Dennison
Univ. of Georgia	Athens, Georgia	Food Technology	Food Technology	J. J. Powers
Univ. of Illinois	Urbana, Illinois	Food Technology	Food Technology	R. T. Milner
Univ. of Maryland	College Park, Md.	Horticulture	Horticulture	Amihud Kramer
Univ. of Massachusetts	Amherst, Massachusetts	Food Technology	Food Technology	W. B. Esselen
Univ. of Missouri	Columbia, Missouri	– – –	Committee	D. E. Brady
Univ. of Wisconsin	Madison, Wisconsin	Dairy & Food Ind.	Dairy & Food Ind.	K. G. Weckel
Virginia Polytechnic Institute	Blacksburg, Virginia	Horticulture	Horticulture	A. Lopez
Washington State Univ.	Pullman, Washington	Horticulture	Committee	Mrs. M. M. Hard

IFT News

CHICAGO

On September 28, 1957, the Chicago Section met jointly with the Indiana Section at Lafayette, Indiana. Features of the day were a barbecue at noon and the football game, Purdue vs. Notre Dame.

Also featured was the presentation of the General Foods Fellowship Award to John V. Spencer, Purdue graduate student, by Dr. Aksel G. Olsen, vice president, General Foods. S. J. Davin, Indianapolis Section, presided.

An excellent idea of the scope of instruction and research was obtained in the orientation visit to the Food Technology Laboratories in the Horticulture Building. Here the graduate work was described and the facilities for research shown.

Tours included:

Foods and Nutrition Department—New Home Economics Building. Taste testing laboratory, animal research, metabolism suite, other laboratories, unit kitchens. The facilities of the Institute Management Department and the teaching laboratories of the Foods and Nutrition Department were to be seen on this tour.

Food Bacteriology—Stanley Coulter Hall. Research in food bacteriology and closely related fields. Frozen foods, antibiotics, fermentation, mycology, microbial physiology. Current graduate students gave short talks on their research. Conventional equipment and some specialized items were seen.

Poultry Products Laboratories—Poultry Building. Quality preservation of eggs and poultry meat. Equipment for egg work included quality measuring

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devices. For meat work there was a small processing plant with freezing facilities (including immersion freezing), shear press for tenderness evaluation, and another press for juiciness measurement. Current research projects include antibiotics in the preservation of fresh poultry meat, factors affecting tenderness of poultry meat, quality of frozen egg products.

SOUTHERN CALIFORNIA PLANS ANNUAL FALL CONFERENCE

Friday, October 18th, has been designated as the date for the SCIFTS annual fall conference for 1957 and the Huntington Sheraton Hotel in Pasadena is the place.

FLAVORS IN FOODS

The morning session, under the chairmanship of Dr. A. J. Haagen-Smit (California Institute of Technology) will be devoted to papers on *Flavors in Foods*. Speakers for this session of the symposium will include:

Dr. Emil M. Mrak
President, IFT

Dr. Henry Klostergaard, California Institute of Technology, Pasadena

Miss Marion Simone, Department of Food Technology, the University of California at Davis

Jean Caul, of Arthur D. Little, Inc., Cambridge, Massachusetts

The luncheon speaker will feature our national president, Dr. Emil M. Mrak, Chairman of the Department of Food Technology, the University of California at Davis. This will be the highlight feature of the conference as there will be no dinner meeting.

CONVENIENCE IN FOODS

Five papers are promised for the afternoon session on *Convenience Foods* under the chairmanship of Dr. Roy Hagen. The speakers for this session include:

Dr. Hans Lineweaver, Western Utilization Research and Development Division, Albany, Calif.

Dr. Fred Talburt, Western Utilization Research and Development Division, Albany

Mr. Jack Low, Wittenborg, Inc. of Portland, Ore.

Mr. Joseph Gray, Raytheon Manufacturing Company, Waltham, Mass.

Mr. Fred Graf, Vice-president of Nielson Company

IFT members and their friends who expect to be in the southern California area on October 18 and wish to attend the conference should contact the undersigned for reservations.

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AUSTRALIA N.

ANNUAL GENERAL MEETING. The annual general meeting was held at the Food School, East Sydney Technical College, on Tuesday, June 4th. The primary business of the evening was the election of office-bearers for 1957-58. This is your committee:

Chairman—H. Govers
Secretary—P. Muller
Treasurer—J. David
Councillor—Dr. V. M. Lewis
Past Chairman—E. Hart
Committee—Miss N. Beale, I. Hall, P. Gibson, W. Hopkins, J. Kefford, E. Davis, J. Roche

Dr. Jack Gregory of the Atomic Energy Commission addressed the meeting and discussed radioactive isotopes in relation to food and the food industry. Keen interest was shown by those present as evidenced by the lively discussion that followed. This, unfortunately, had to be curtailed somewhat as Don Grover was noticeably eager to lead us to the festive board—and what a magnificent repast awaited us—roast turkey, chicken, ham, pork, and lamb—with all the trimmings. For a memorable evening, congratulations are due to Don, his staff, and pupils.

At the time of the General Meeting our membership in the Australian Northern Section numbered 125.

Programme for 1957-1958

Your programme committee has been hard at work, and submits the following proposed programme:

1957	
July 25, 2:30 p.m.	Inspection of M. B. & T. Vinegar Factory and Research Laboratories.
August 27	Dr. George F. Stewart, Professor of Poultry Husbandry, University of California, Homebush.
September 19, 23, 24, or 25	Dinner to Col. Chas. S. Lawrence, IFT Executive Secretary. Site to be announced.
October-November	Conjoint meeting with Dieticians. "Fats and Heart Disease" or "Low Calories Diets"—East Sydney.
December	Second annual Christmas barbecue at Cronulla.
1958	
February	Inspection of Toohey's or Schweppes!
March	Talk by Peter Gibson on his visit to America.
April	Inspection of A. I. S. Tinplate Mill, Port Kembla.
May-June	Convention—Hotel Canberra, Canberra.
June-July	Annual Meeting.

Literature

BOOKS

THE FREEZING PRESERVATION OF FOODS. Vol I. FREEZING OF FRESH FOODS. Donald K. Tressler and Clifford F. Evers. 3rd. Ed. (Avi Publ. Co., Westport, Connecticut) $18.00 (domestic) and $19.00 (foreign), 31 chapters and 1240 pages.

To Donald K. Tressler belongs credit for the initiative to bring together and systematize our knowledge of food freezing. For

Tressler (left) and Evers (right) co-authors of newly issued, extensively revised The Freezing of Foods, Volume I.

more than a decade, the *Freezing Preservation of Foods* by Tressler and Evers has been a great asset and almost indispensable not only in the U. S. but also overseas. Together with the German book Peach: *Die Gefrierkonservierung*, with its broader emphasis on the theories of freezing, it has undoubtedly been the basic source of information on freezing research and technology.

An impressive amount of knowledge has been gathered together in this new edition—almost an encyclopedia on freezing. Attached to the preface, to attest to the range of consultative sources, is a lengthy list of scientists, technologists, and industrialists, who have been approached for comments and additional information. This is indeed a giant and most praiseworthy undertaking.

Need for an Historical Approach

It is a question of temperament and approach where you put emphasis in presenting so huge a body of material as this. The reviewer would have liked to see a somewhat more critical evaluation

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of present trends and greater consideration of important theoretical accomplishments by other countries than the U. S. A.

Most beneficial to a correct understanding of the modern frozen food industry would have been an introductory chapter, dedicated to the history of food freezing and not, as now, restricted to a few *ad hoc* observations. Few realize the extent of food freezing in Russia (veal, fish, milk, etc.) in the early days, and the application of freezing to fish and other animal products in parts of Europe at the start of the 19th century. These developments anticipated mechanical refrigeration by many decades, and taught us many interesting lessons in welding mechanical refrigeration into a method for food preservation. Salmon, for example, was frozen commercially through ice-salt mixtures in eastern England, Scotland and in parts of Ireland for delivery to London and other British cities. Freezing preservation of food was in fact discussed in Scottish papers in the days of Appert as an important alternative to his new method of canning.

In reviewing the freezing of fish at sea, omission of accomplishments outside U. S. is most obvious. Very important contributions were made in the thirties, thanks to the efforts of the great maritime fishing nations—the United Kingdom, Russia, Japan, and Norway. In addition, France, Germany, and Italy built several experimental freezing ships. All this would have been worthy of mention as well as the great wealth of valuable information they collected in their pioneering efforts. The important theoretical studies by the Norwegian scientist Watzinger on fish freezing in packages definitely deserved attention.

New Values Added

Important new chapters have been added to this new and largely augmented third edition. Mention should be made of the discussions on dehydrofreezing, vacuum concentration, freeze-drying, and freezing concentration. These are valuable reviews and good sources of references. Particularly, the chapter on dehydrofreezing should be commended on account of its logical strictness, thorough penetration, and its many suggestions for industrial applications.

This new edition has been vastly expanded also in the field of marketing and warehousing. The handling of frozen food during transportation and in retail stores is vitally important to final quality, and hence these chapters are amply justified.

Notations for Reference in a Future Revision

The whole book would have benefited by more strict editing. In general, the entire body of material needs further digestion. Much information is of an ephemeral nature, and several important finds are not reported on at all. This shortcoming is particularly felt in the general discussions on the freezing of meat and fish. It is true that the book is extremely comprehensive, containing an incredible assembly of facts, sometimes beyond the limit of importance. Nevertheless, after reading the book through three times, the reviewer has the feeling that pertinent information is lacking. One serious omission may be indicated here as an example. The great wealth of knowledge collected by British and Australian sources as to meat freezing and the handling of frozen meat undoubtedly would have greatly improved the meat chapter. Both in theory and practice they have made important contributions. The basic problem of the relationship between the stage of rigor at freezing and the amount of drip is not even mentioned. The Danish innovation of direct immersion freezing in sols of glycerol and alcohol and the German method of applying fluid nitrogen oxide as a freezing medium are both interesting and deserve consideration.

To a true understanding of the principles of freezing and their practical implication the reviewer feels it almost imperative to clarify the basic differences between the freezing of a respiring fruit and vegetable tissue as compared to that of animal tissues, as meat, poultry, etc. Also the specific laws governing the freezing of fluids as juice concentrates, milk, soups, etc.

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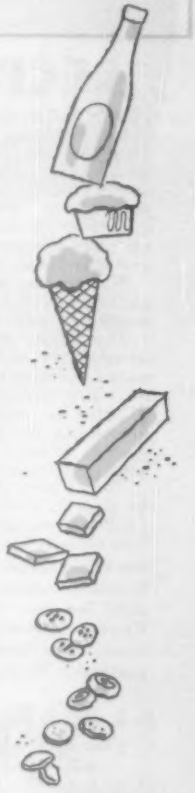

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need clarification and definition. Not even the consequences of the fundamental phenomena of the volume increase in the formation of ice are analyzed. The outmoded cell rupture theories require discussion in the light of several later findings.

Photographs and diagrams are not well reproduced and several of the pictures convey no clear information. Trend diagrams are preferable to statistical data, which rapidly become obsolete in a textbook planned to be used for many years. Most of the statistical information is only brought up to the year 1953 or, occasionally, to 1955. In future editions serious consideration should be given to deleting the chapters on the principles of refrigeration and cold storage, covering such topics as systems of mechanical refrigeration, refrigerants, warehouse design, construction, and insulation as well as insulation materials. All this information is readily available in any general textbook on refrigeration. By restricting the book to the food aspect of freezing it would also be more reasonable in size, which would give this valuable book a price within easier reach of all students of frozen foods.

This book also clearly brings out the need of a more strict terminology in the field of food freezing. Space does not permit a penetration of the many problems in this respect. But the semantic problems of freezing become more evident when such an encyclopedia becomes available and so much information is accumulated in a restricted space. Two examples: the use of the term *fresh food* should be abandoned. The term as such has at least six different meanings. We should always use terms as farm-fresh, orchard-fresh, sea-fresh, oven-fresh, dairy-fresh, etc. but not *fresh* as such. "Fresh" is now frequently used to signify such different states or conditions as raw, unprocessed, non-decayed (non-moldy), newly harvested, newly prepared, etc. Frozen strawberries after defrosting are not more fresh than most other preserved products of this item. Does not the same statement apply to most fruits and berries and certainly to the partly cooked blanched vegetables? The peculiar assertion (p. 923) that freezing gave us a third type of foods—fresh and prepared foods—certainly needs modification.

The freezing *treatment* of products should be distinguished from the actual freezing *process* in the product. This is rarely done and creates confusion not only in this textbook but in most publications on freezing of foods. A true distinction in this respect reflects on the use of terms like *freezing rate* and *freezing time*.

"A Must on the Bookshelves of Food Technologists"

It is always difficult to combine the idea of a manual (engineering handbook) with a scientific treatise. Both types of publications are highly needed in the field of food freezing. Neither category of readers will be wholly satisfied by the present volume. The scientist needs more basic information and creative presentation. The engineer wants more operational advice. Nevertheless, this new edition is most welcome and is certainly needed. *The Freezing Preservation of Food*, Vol. I, is a *must* on the bookshelves of every food technologist. Certainly, we all have reason to be highly grateful to Donald K. Tressler and Clifford Evers for their magnificent accomplishment. They have compiled a very useful source-book on the freezing of food in the U. S. A. and the problem of handling frozen foods.

This book can be said to mark the end of an era which began with Rudolf Plank and Clarence Birdseye. The frozen food industry has come of age. The intervening years have been fruitful and the world —not only the U. S.—owes much to Donald K. Tressler and his co-author, Clifford Evers, for disseminating knowledge of commercial operations in the field of food freezing, but the future of frozen foods largely rests on science. In our new era—adulthood—we are forced to advance the frontiers of our knowledge in such diversified areas as frozen food microbiology, bio-engineering, colloidal structure and enzymology. Otherwise the present deficiencies in our knowledge in these and other respects

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might very well turn the remarkable progress of the latter decades into failure. The battle is not won. Frozen foods have not yet, in spite of all advances, attained a pivotal position in the modern food industry.

GEORGE BORGSTROM
East Lansing, Michigan

METHODS OF BIOCHEMICAL ANALYSIS. Volume IV. Edited by David Glick. Interscience Publishers, Incorporated, New York, 1957 x + 362 pp. including indices.

Several chapters in this, the fourth volume in the series edited by David Glick, professor of Physiological Chemistry at the University of Minnesota, will certainly be of great interest to food chemists engaged in nutritional research or analysis.

In "The Determination of Carotene," E. M. Bickoff, of the United States Department of Agriculture, discusses the relationship between the provitamin A carotenoids and their vitamin A biopotency. The effects of specific steps in the chemical assay procedures on the various provitamin A carotenoids and the resulting significance of the data are summarized. Procedural details for the determination of carotene in various vegetable and animal products are presented.

"Determination of Vitamin A" by N. D. Embree, S. R. Ames, R. W. Lehman and F. L. Harris of Distillation Products Industries provides a logical sequel to the first chapter. The authors review the properties of vitamin A as well as the various bioassay and physiochemical methods used. Detailed procedures for specific food, feed and biological materials are given.

Ralph T. Holman, of the University of Minnesota, contributed the chapter on "Measurement of Polyunsaturated Fatty Acids" in which the chemical, spectrophotometric and paper chromatographic methods of determining polyunsaturated fatty acids are described. The clarity and detail of the presentation renders this chapter a source of information on contemporary analytical technics, which nutritionists and fats and oils chemists will find invaluable.

"Determination of Amino Acids by Use of Bacterial Amino Acid Decarboxylases" by Cambridge University's Ernest F. Gale, should stimulate considerable ininto failure. The battle is not won. Frozen foods have not yet, in spite terest in this relatively new mode of amino acid determination. Useful notes on the estimation of specific amino acids by this method are provided by the author.

Other chapters in this volume are: Determination of 17,21-Dihydroxy-20-ketosteroids in Urine and Plasma, by R. H. Silber and C. C. Porter.

The pH-Stat and Its Use in Biochemistry, by C. F. Jacobsen, J. Léonis K. Kinderstrøm-Lang, and M. Ottesen.

Assay of Sulfatases, by K. S. Dodgson and B. Spencer.

Determination of Serum Acid Phosphatases, by W. H. Fishman and H. M. Davidson.

Determination of Succinic Dehydrogenase Activity, by T. P. Singer and Edna B. Kearny.

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ABSTRACTS

—Compiled by H. A. Campbell

ANALYTICAL METHODS

The chromatimer or chromatograph monitor.

BLAKE, G. G. (Sydney Univ., N. S. W. Australia). *Chemistry & Industry*, 1957, 248–9.

A device for stopping the progress of chromatographic formation automatically at any stage is described.

An improved method for estimating ascorbic acid in foods and biological material.

MOOR, H. (F. Hoffmann-La Roche & Co., Boston). *Food Manuf. 32*, 119–21 (1957).

Swiss workers have developed a colorimetric method for estg. ascorbic acid in foods which is claimed to be more sensitive and specific than former methods. Principles and procedure are given in this article.

Quantitative determination of L-glutamic acid by L-glutamic acid decarboxylase.

SEIDMAN, M. AND BLISH, M. J. (Research Division, International Minerals and Chemical Corp., Skokie, Ill.). *J. Agr. Food Chem. 5*, 448–52 (1957).

An accurate method adaptable for the routine detn. of L-glutamic acid in foods and pharmaceuticals, raw materials used in manufg. monosodium glutamate, and plant process streams was needed. A modification of the method of Umbreit and Gunsalus, using L-glutamic acid decarboxylase prepd. from *Escherichia coli* ATCC strain 4517 gives values, which are accurate and reproducible within narrow limits, and is well adapted to routine analytical work.

The determination of sorbitol.

ADCOCK, L. H. *Analyst 82*, 427–34 (1957).

Samples presented for detn. of their sorbitol content often contain carbohydrates and the intramolecular ethers of sorbitol, usually referred to as the monoanhydrides of sorbitol. These interfere with the detn. of sorbitol by oxidation with periodate. Separation of sorbitol from carbohydrates has been effected by degradation of the carbohydrates with alkali, followed by removal of the degradation products by means of ion-exchange resins; paper chromatography has been used for the sepn. of sorbitol from its anhydrides and other substances that react with periodate. Periodate procedures have been adapted to suit the various amts. of sorbitol sepd. by these methods, which range from 1 to 400 μg. Examples are given of the application of these procedures to food samples, technical products and biol. materials.

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BIOLOGICAL SCIENCES

Biochemistry

1-Aminocyclopropane-1-carboxylic acid: A new amino-acid in perry pears and cider apples.

BURROUGHS, L. F. (Long Ashton Research Sta., Univ. of Bristol). *Nature 179*, 360–1 (1957).

The isolation from cider and pear juice, identification, structure proof, and synthesis for 1-aminocyclopropane-1-carboxylic acid are described.

Microbiology

Studies of inhibitors of bacterial and other hyaluronidases. I. Specific and nonspecific serum inhibitors.

HADIDIAN, Z., MAHLER, I. R. AND MURPHY, M. M. (Tufts Univ. Sch. of Med., Boston, Mass.). *J. Bacteriol. 73*, 484–90 (1957).

The specific inhibitor of any one of the enzymes of the three organisms, *S. mitis* No. 19, *D. pneumoniae* and streptococcus group K, is equally effective against the other two. There is no other cross-inhibition. The heat-stable inhibitors of human serum have the same pattern of specificity as the specific inhibitors obtained from rabbits. *In vivo* expt. indicate that an enzyme susceptible to both the nonspecific and a specific inhibitor reacts with the specific inhibitor in the circulation before it reacts with the nonspecific inhibitor.

Nutrition

Lysine, threonine and other amino acids as supplements to rice diets in man: amino acid imbalance.

HUNDLEY, J. M., SANDSTEAD, H. R., SAMPSON, A. G. AND WHEDON, G. D. (Natl. Inst. of Health, Bethesda, Md.). *Am. J. Clin. Nutrition 5*, 316–25 (1957).

The N balance technic was used in five normal young adult males to evaluate certain amino acids as supplements in rice diets. The positive effects of the amino acid supplements are interpreted as being due in part to the N supplied. Lysine, and perhaps methionine, seemed to exert a "specific" effect in improving protein utilization over and above their N contribution in some, but not all subjects. The highly significant negative response to lysine plus threonine in one subject and to a mixt. of the 8 essential amino acids in another is interprted as providing evidence for the importance of amino acid balance in man.

Amino acid and protein requirements of infants.

PRATT, E. L. (Univ. of Texas Southwestern Medical School, Dallas, Texas). *J. Am. Med. Assoc. 164*, 408–11 (1957).

Our knowledge of protein nutrition in humans is scanty and uncertain, largely because of the inherent difficulties in the evaluation of human nutrition. Therefore, those who must interpret nutritional expts. and give advice about diets to patients must exercise considerable caution. The present lack of knowledge makes it mandatory that pediatric patients be taught to enjoy eating a wide variety of natural foodstuffs. A plea is made for valid evidence before the procedure of supplementing proteins in the diet with individual amino acids is accepted.

Biological evaluation of proteins: a new aspect.

BENDER, A. E. AND DOELL, B. H. (Bovril Ltd., 148 Old Street, London, E. C.). *Brit. J. Nutrition 11*, 140–8 (1957).

A modification of the commonly used growth method of assessing the nutritive value of proteins, the protein efficiency ratio, is described and tentatively named protein retention efficiency (P.R.E.). The procedure for obtaining this index consists of feeding a group of four rats on a diet contg. 10% of the test protein, and a group of litter-mates on a non-protein diet. After 10 days feeding, the (algebraic) difference between the gains in wt. of the two groups divided by the wt. of protein eaten is defined to be the net protein ratio (N.P.R.). This ratio multiplied by 16, to coreet it to a range of 0–100, is called the P.R.E. The P.R.E. was shown to correlate extremely highly with the net protein utilization detd. by carcass analysis, and to be independent of food intake. It includes the maintenance requirements of the test animal as well as the growth requirements.

Relative nutritive values of proteins in various foods at increasingly high levels of protein intake.

SURE, B. (Dept. of Agricultural Chemistry, Univ. of Arkansas, Fayetteville, Ark.). *J. Agr. Food Chem. 5*, 463–4 (1957).

The nutritive value of the proteins in various foods at increasingly high levels of protein intake was studied for possible practical application in poultry and livestock feeding. Protein efficiency decreases with increased protein intake because there is greater waste in metabolism with the increased ingestion of protein. In all the foods studied, 15% was the most efficient level of protein intake.

Nitrogen balance and the nutritive value of proteins.

ALLISON, J. B. (Rutgers Univ., New Brunswick, N. J.). *J. Am. Med. Assoc. 164*, 283–9 (1957).

A review of protein nutrition and metabolism. The concept is developed that protein stores are continually being broken down through catabolism, thereby providing energy and amino acids for the metabolic pool. This pool may be particularly important to provide energy and essential amino acids during periods of malnutrition assocd. with sickness, stress, or low food intake.

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Effect of low-protein diet on the chemical composition of the bodies and tissues of young rats.

WIDDOWSON, E. M. AND MCCANCE, R. A. (Medical Research Council, Dept. of Exptl. Med., Univ. of Cambridge). *Brit. J. Nutrition 11*, 198–205 (1957).

The compn. of the liver and skeletal muscles and the total N in the bodies of young rats were investigated after (I) a diet very low in protein, (II) a high-protein diet limited in quantity to maintain the animals at the same wt. as those on diet (I), (III) a 1:1 mixt. of the two diets in unlimited amts. Diet (I) reduced the wt. of the liver and the percentage of N in it, but made no real difference to the compn. of the cells of the rest of the body. Rehabilitation after diets (I) and (II) led to growth with deposition of N in the body cells and a corresponding gain in wt., but no addnl. storage of N in the cells without the expected amts. of K and H_2O.

The effect of increased dietary fat upon the protein requirement of the growing dog.

ONTKO, J. A., WUTHIER, R. E. AND PHILLIPS, P. H. (Univ. of Wisconsin, Madison). *J. Nutrition 62*, 163–9 (1957).

Data show that, under ad libitum feeding, increased increments of dietary fat in the ration of the weanling dog increased the present protein requirement as measured by rate of growth and by food efficiency. The diet which contained 20% fat needed 25.0% protein to obtain a max. growth response in the weanling pup in these expts. Further increases in protein were needed to obtain a max. growth and food efficiency rate when the diet contained 30% fat. The food efficiency for the weanling pup was distinctly superior with the 30% fat diet over that with the diet which contained 20% fat.

Fats in the diet.

GRIFFITH, W. H. (Univ. of California Medical Center, Los Angeles). *J. Am. Med. Assoc. 164*, 411–12 (1957).

Until a clear-cut solution of the problem of the prevention of arteriosclerosis and of its sequelae is forthcoming, it seems wise to assume that a faulty diet may be one of the causative agents. Whether or not dietary fat is, in some fashion, the culprit remains to be proved.

Nutrition and behavior.

Univ. of Minnesota, Minneapolis, Minn.). *Am. J. Clin. Nutrition 5*, 332-43 (1957).

BROŽEK, J. (Sch. of Public Health, The richness of diets, particularly in respect to animal fats appears to be the principal biologic factor differentiating areas of high and low mortality due to coronary heart disease. It may be that food habits, with special emphasis on fat intake, and the attempt to modify these habits in the light of the accumulating evidence of the health significance of dietary fats, will represent the most important issues in studies on nutrition and behavior during the next ten years.

Serum cholesterol in Japanese coal miners. A dietary experiment.

KEYS, A., KIMURA, N., KUSUKAWA, A. AND YOSHITOMI, M. (Univ. of Minnesota, Minneapolis). *Am. J. Clin. Nutrition 5*, 245–50 (1957).

The expt. shows that it is reasonable to attribute the low cholesterol values in Japanese to their diet and it is unnecessary to invoke theories about race or physical labor as conceivable prime factors. The outstanding peculiarity of the diet, is the fact that total fats provide only about one-fourth the proportion of cal. from fats currently used in the av. U. S. diet (10.3 vs. 40' percent of cals. from fats).

Relations between arteriosclerosis and the serum cholesterol level.

DAVID, P. AND EDDIE, E. *Union med. Canada 86*, 155–9 (1957); *J. Am. Med. Assoc. 164*, 604 (1957).

Hypercholesterolemia appears not to be indispensable for the formation or development of atherosclerosis, since many patients with this disease have normal serum chlosterol levels. Disorders of the total lipid metabolism in patients with atherosclerosis might be reflected in the cholesterol metabolism. Hypercholesterolemia, therefore, may indicate atherosclerosis, but this is far from being the rule, because many factors affect the cholesterol metabolism.

Corn oil and hypercholesteremic response in the cholesterol-fed chick.

JONES, R. J., REISS, O. K. AND HUFFMAN, S. (Univ. of Chicago, Ill.). *Proc. Soc. Exptl. Biol. Med. 93*, 88–91 (1956); *Fats, Oils, Det. A:165.*

Higher level of serum cholesterol is achieved when cottonseed oil is fed instead of corn oil. Whole corn germ was a much more potent agent for limiting hypercholesterolemia and early atherosclerotic lesions than the more refined products. The difference between corn oil and cottonsed oil in the effect on the hypercholestereremic response of the cholesterol-fed chicks cannot be explained by a difference in fatty acid compn.

Utilization of fructose, galactose and glucose by diabetic rabbits.

BANERJEE, S. AND RAMANKUTTY DIVAKARAN, E. (Presidency Coll., Calcutta, India). *Am. J. Physiol. 188*, 543–6 (1957).

Fructose, galactose and glucose were fed to normal and alloxan-diabetic rabbits. The levels of these sugars and true glucose were estd. in samples of blood. Fructose and galactose were removed from the blood very rapidly in both the normal and diabetic rabbits and insignificant amts. of these sugars appeared in the urine. Alloxan-diabetic rabbits in spite of their normal ability to initiate the metabolism of fructose and galactose, either transform a considerable amt. of these sugars into glucose or spare the utilization of blood glucose.

Vitamin B_{12} absorption in pregnancy and in the newborn.

HELLEGERS, A., OKUDA, K., NESBITT, R. E. L., SMITH, D. W. AND CHOW, B. F. (Johns Hopkins Hosp., Baltimore, Md.). *Am. J. Clin. Nutrition 5*, 327–31 (1957).

Absorption of orally administered vitamin B_{12} is significantly increased by pregnancy in the human and in the rat. As yet, pregnancy is the only known method of increasing vitamin B_{12} absorption in the adult.

Nature, nurture, and nutrition.

MONTAGU, M. F. A. *Am. J. Clin. Nutrition 5*, 237–44 (1957).

Because the problem of nutrition is largely a cultural one, the approach to its solution must be principally through cultural means. The problem of nutrition is, surely, how one can get human beings to eat foods which at every stage of their growth and development are those most likely to contribute to their optimum health. Taking the world as we find it, and speaking for our culture alone, it seems that it is through education that our people can best be taught how to eat as they should.

Obesity and hypertension among young adults.

SZENT-GYORGYI, N. (Sch. of Medicine, Univ. of Chicago). *Am. J. Clin. Nutrition 5*, 274–8 (1957).

In 3,508 college students the incidence of hypertension was 8.1% among the American and 4.9% among the foreign-born males. It was found that 979 or 27.9% of the students (29% of the males and 23.9% of the females) were overweight. The incidence of hypertension was 4.9% and 11.3% resp., among the non-obese and the obese students. The difference is highly significant, there being more than twice as many hypertensives among the obese as among the non-obese. Of the obese 12.4% and of the non-obese 6.3% of the American males were hypertensive.

The Vanderbilt cooperative study of maternal and infant nutrition. X. Ascorbic acid.

MARTIN, M. P., BRIDGFORTH, E., MCGANITY, W. J. AND DARBY, W. J. (Vanderbilt Univ. Sch. of Med., Nashville, Tenn.). *J. Nutrition 62*, 201–34 (1957).

Data on intakes and serum levels of vitamin C in 2,129 pregnant women were studied. Serum levels decreased during pregnancy except in the group at a high level of intake. Evidence is presented that on the av. intakes of 80 to 100 mg. daily supported high levels of ascorbic acid

Continued on page 64

Gentle as a to baby foods

fmc Hi-Pressure steam peeler

Three FMC Steam Peelers prepare a variety of fruits and vegetables for baby foods at Beech Nut's San Jose, California plant.

LOOSENS FRUIT AND VEGETABLE SKINS FAST WITH MINIMUM HEAT PENETRATION TO THE PRODUCT

No harsh chemical solutions used with this equipment! Products are simply exposed to steam under pressure (up to 120 P.S.I.G.), and in a matter of seconds even the toughest skins are uniformly loosened, making skin elimination easy, fast and thorough. There's no damage to the tender subsurface nutritional layers of the product, no excessive product waste.

Built for various capacity requirements up to 10 tons per hour, the FMC Steam Peeler increases yield by 7% to 10% or more, at the same time doing away with the high cost and disposal problems associated with chemical peeling. Such fruits and vegetables as pears, peaches, apples, carrots, beets and potatoes are gently and efficiently processed in continuous, automatic operation.

Full information is contained in our "Steam Peeler Facts" Bulletin, Volume 5, No. 2. Write for your copy today, or call your nearest FMC representative.

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INDUSTRY PUBLICATIONS

The use of **Tenox Antioxidants** in extending the fresh life of nuts is discussed in a new brochure issued by the food laboratories of Eastman Chemical Products, Inc., Kingsport, Tenn. Typical data illustrating the effectiveness of various Tenox formulations in extending the storage life of several kinds of nuts are included, together with details of various methods of applying the antioxidants.

Macbeth Daylighting, for the critical viewing and grading of foods, is discussed in detail in a comprehensive, easy to follow, four-page bulletin being offered free to food processors. Copies can be obtained by writing Dept. P-8, Macbeth Daylighting Corp., Newburgh, N. Y., and requesting Bulletin No. 271.

Antioxidants in Meat is the subject of a handy wall chart produced by the Chemical Sales Div., Chas. Pfizer & Co., 630 Flushing Ave., Brooklyn 6, N. Y. Scanning of the chart shows the correct amount of isoascorbic acid or sodium isoascorbate solution to be added according to the desired level of use and meat chopper capacity. Direct readings can be obtained for chopper capacities up to 800 lb.

Methodology of Sensory Testing, proceedings of the IFT Symposium in Pittsburgh in May 1957, is available at cost ($1.00 per copy) at The Garrard Press, 510–522 North Hickory, Champaign, Illinois.

Plant Sanitation training help now is available to customers of the Diversey Corp., 1820 W. Roscoe St., Chicago 13, in the form of an educational series of pamphlets and posters. Prepared in friendly and informative fashion, the six pamphlets discuss various phases of good clean-up practice; the posters, reproduced in full color, are designed to serve as constant reminders of the need for good plant sanitation. A sample folder and poster may be obtained by writing to the company's In-Plant Training Dept.

Critical Data Tables (Corn Industries Research Foundation, Inc., 1001 Connecticut Avenue, N.W., Washington 6, D.C.) have been compiled by George E. Carson. This is a completely revised compilation with new tables added. Material is sectionalized as follows: corn syrups; corn sugars; dextrose and sucrose; starch and dextrin; vegetable oils; feed and grain; factors, correction, conversion tables; humidity and water; miscellaneous, including bolting cloth, sieves, etc. A useful subject-matter index concludes the 452-page manual.

A **Laboratory Manual for Food Microbiology,** prepared by Professors Frazier and Foster, University of Wisconsin, has been published by Burgess Publishing Co., 426 S. Sixth St., Minneapolis 15, Minnesota, at a per unit price of $2.50. This is a teaching manual primarily but has reference value for the technician engaged in methods work.

Continued on page 66

EQUIPMENT

Dilatometry Apparatus. A new dilatometry unit is said to make possible quick, easy determinations of solid fat index. Four low-temperature and three high-temperature baths cover the 0-60° C. range, and individual thermoregulators control the temperature setting of each bath. Designed specifically for the A.O.C.S. method, the unitized design is said to save space while increasing accuracy and efficiency. Complete descriptive literature and prices are available from Wilkens-Anderson Co., 4525 W. Division St., Chicago 51.

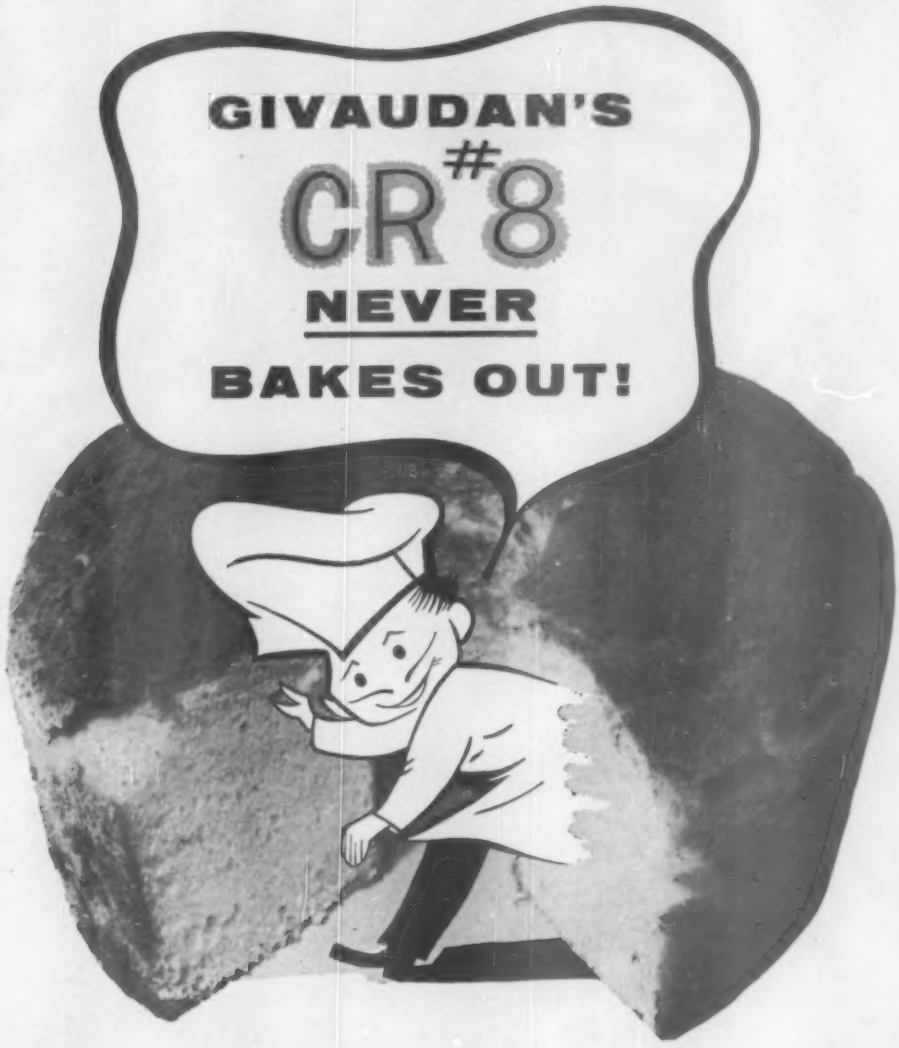
Nylon-Lined Bottles. After three years of research and development work, the Plastic Container Div. of Continental Can Co. has announced perfection of a nylon-lined polyethylene bottle said to be ideal for many packaging purposes. The nylon lining, from 0.001 to 0.002-in. thick, eliminates product permeation in almost all instances. Continental can apply the new lining in all Boston round, cylinder and oval bottles, within certain limitations. Treated in this way, containers are able to hold products which, because of permeability and solubility characteristics, cannot be kept in regular polyethylene bottles.

Information can be obtained from Continental Can Co., 100 E. 42nd St., New York 17.

Paint-Shaker Mixer. Red Devil Tools has reported that its Red Devil No. 30 paint mixing machine is being applied in the food industry to mix flavors, colors and other additives in regular production runs, where small quantities of additives are involved. The paint shaker is said to do equally as good a job as more specialized and more expensive equipment.

The No. 30 paint conditioner handles ¼-pt. to 1-gal. cans and is equipped with a quarter-horsepower motor that operates the conditioner at the rate of 1,350 shakes per minute. Average mixing time, which varies with the consistency and amount of material, is about two minutes. Also available are smaller and larger models that

A complementary additive to vanilla flavors...



Baked products faithfully retain their vanilla odor, taste and flavor strength when Givaudan's C. R. #8 is used as a fixative. Its resistance to high as well as low temperatures has been *proved in actual use* by the baking, candy and ice-cream industries. C. R. #8 is soluble in alcohol and propylene glycol. C. R. #12—a variation of C. R. #8—is also soluble in vegetable oil. Both are coumarin-free.

C. R. #8 is only one of Givaudan's *proved-in-use* products. You can rely on Givaudan for custom-made or standard flavors that *always* meet your requirements. Samples and literature on request.

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handle maximum can sizes of one quart and five gallons.

For information, write Red Devil Tools, Union, N. J.

Radioactivity Density Gauge. Ohmart Corp. has introduced a new instrument designed to measure or control process variables accurately by measuring the density, specific gravity or percentage of solids of the process material. The instrument, a radioactivity density gauge called the Model LSG, is intended to meet the need for a lower-priced unit suitable for applications requiring a high degree of precision but not necessarily the extreme sensitivity claimed for the firm's senior instrument, the Model SG.

Model LSG employs gamma radiation and the Ohmart Cell in the measurement function. Because all measuring components are located outside the vessel carrying the process material, operation is not affected by high or low temperature, pressure, viscosity, corrosion or abrasion. Safety is said to be insured by a unique lead-shielding holder for the radioactive source.

For information, write Ohmart Corp., 2236 Bogen St., Cincinnati 14.

PRODUCTS

Chocolate-Vanilla Flavor. Just released by Dodge & Olcott, Inc., 180 Varick St., New York 14, is a new chocolate-vanilla flavor, in powdered form, called Cocoa-Van. While the production of synthetic coatings has been a real boon to candy manufacturers formerly faced with discoloration problems during the summer months, such coatings, according to D&O, are quite low in flavor value. Cocoa-Van is said to overcome this disadvantage by adding a rich, full, authentic chocolate flavor. Prices and specifications are available from the company.

Aid to Peach Processing. A new method for simplifying and improving the preparation of peaches for canning and freezing has been developed in the food research laboratories of Calgon Co., a division of Hagan Chemicals & Controls, Inc., 323 Fourth Ave., Pittsburgh.

The new method consists in adding specified amounts of Calgon to the blanching and cooling waters used in peeling peaches prior to the actual canning or freezing process.

A powdered form of sodium hexametaphosphate, Calgon is used extensively throughout the food processing, dairy and meat packing industries. As applied to peaches, according to Dr. B. R. Suri, Hagan food technologist, Calgon allows the skin to roll back smoothly at the slightest touch. Since there is no tearing of flesh, fruit loss is kept at a minimum.

Steak Tenderizer. An improved liquid steak tenderizing dip has been developed by Freezer Laboratories, Inc., after testing in production on 1½ million pounds of beefsteaks over a period of two years. The company says that the tenderizer, called FM-102, is intended to provide three main advantages: uniform tenderizing without mushiness; natural, enriched meat flavor, with no off-tastes; and low cost. Details can be obtained from the manufacturer at 3755 S. Racine Ave., Chicago 9.

New Cranberry Food. Spiced cranberries, a new form of an old favorite food, are now being marketed as a result of the work of an IFT member, K. G. Weckel, professor at the University of Wisconsin. It was Prof. Weckel who developed Cransweet, a processed cranberry somewhat sweeter than usual but with all the characteristic flavor. From Cransweet was developed the spiced cranberry preparation, with an added tangy spice that is said to make it perfect as a garnish, appetizer or hors d'oeuvre. Processed by Cranberry Products, Inc., Eagle River, Wis., Cransweet and spiced cranberries currently are available in the Midwest and New England states.

High-Temperature Lubricant. Lehigh Chemical Co., Chestertown, Md., recently announced development of an extreme-high-temperature oil, Anderol L-825, designed for use on conveyor belt operations where operating conditions and temperature ranges require an exceptionally versatile lubricant. The operating range of Anderol L-825 is rated up to 500° F. for continuous use, and over 600° F. for short periods. Under these conditions, the product is said to give twice the film strength and load-carrying properties, and only one-quarter the volatility, of the best wide-temperature range lubricant previously available commercially.

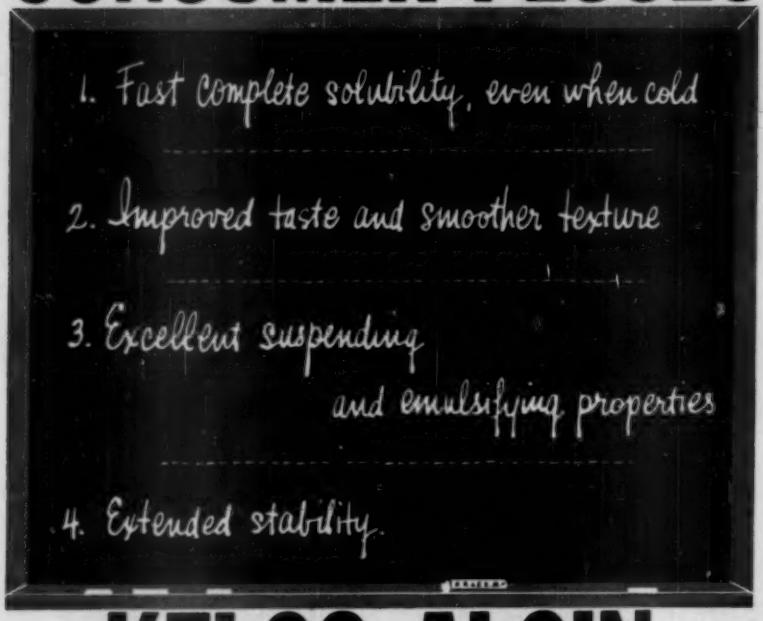
PERSONNEL

Carroll A. White has been named sales manager of the container department of the Dewey & Almy Chemical Co. Div. of W. R. Grace & Co. Mr. White, an IFT member, formerly served as a product manager and an assistant sales manager for the company.

Harry O. Stark has been appointed to a newly created post in the vitamin division of Hoffmann - La Roche, Inc. Mr. Stark will devote his time to bulk vitamin sales to the drug industry and has been given the title manager of pharmaceutical sales.

Harry O. Stark

Now give your dry food mixes these FOUR BIG CONSUMER PLUSES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Dr. Jack H. Mitchell, Jr., has been appointed as Head of the Department of Food Technology and Human Nutrition at Clemson College, Clemson, S. C. Just prior to accepting the appointment at Clemson, Dr. Mitchell was, for seven years, a member of the staff of the Quartermaster Food and Container Institute in Chicago, where he was Chief of the Chemistry and Microbiology Branch.

Dr. Wm. B. Esselen has been appointed to the headship of the Department of Food Technology at the University of Massachusetts, Amherst, succeeding Dr. Carl R. Fellers, retired.

Dr. W. B. Esselen

Frank Linehan has been named manager of the Stockton, Calif., plant of the Tri-Valley Packing Assn., San Francisco. He formerly was with the Aron Canning Co. and the Rogers Canning Co.

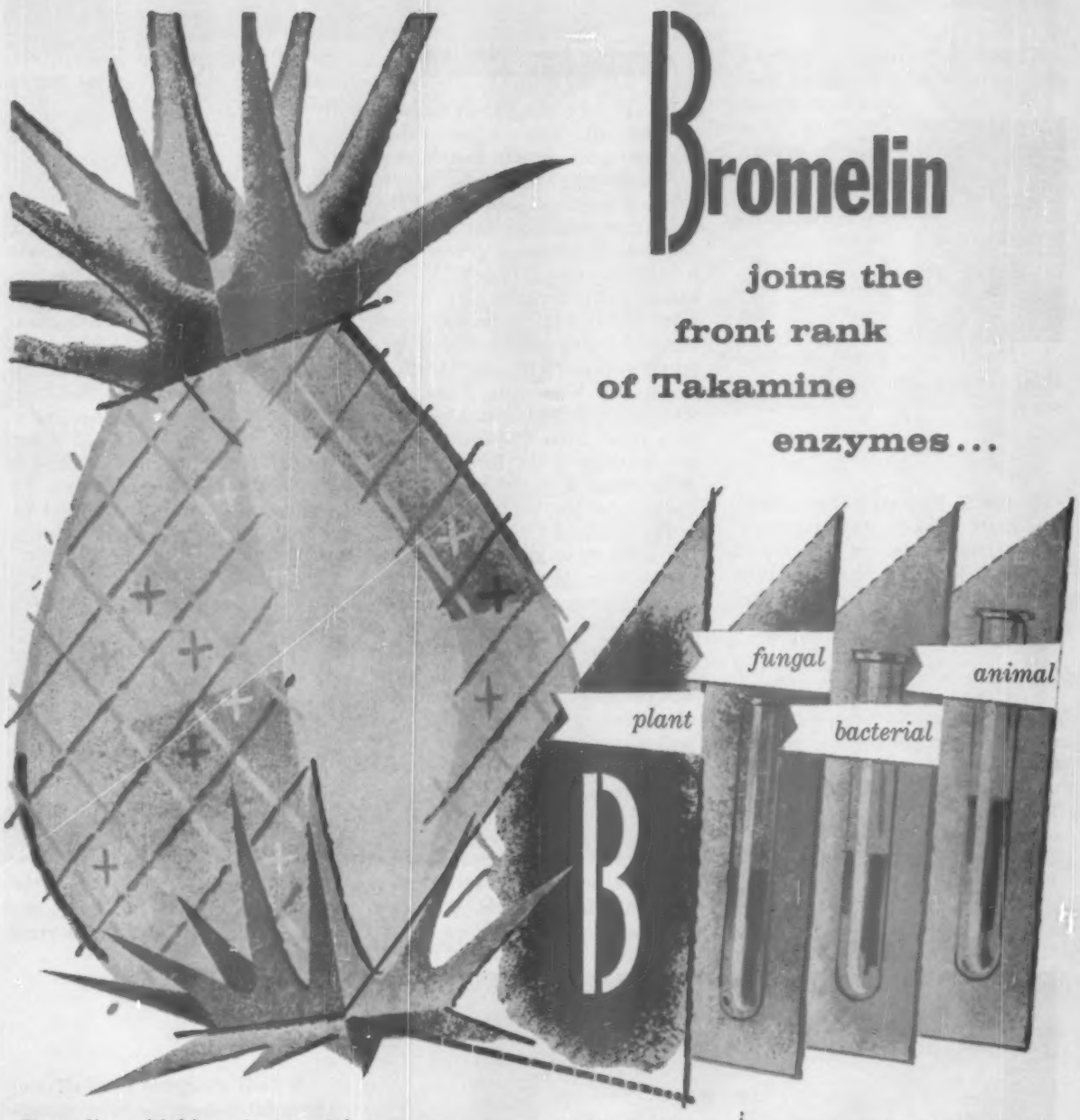
Joseph L. Fortescue is the new manager of the Philadelphia office of Ungerer & Co., Inc., in charge of sales and customer service in that territory.

J. L. Fortescue

Stewart M. Rice, an IFT member and formerly Midwest regional sales manager for the Vacu-dry Co., has opened his own brokerage business in South Haven, Mich. He is specializing in meat products, dehydrated foods, salad oils and shortenings for institutional feeding.

Bromelin

joins the front rank of Takamine enzymes...



Bromelin, a highly potent protein-digesting enzyme derived from the pineapple plant, is excellent for use in meat tenderizers, baked goods, chillproofing beer and in many other food applications. New *bromelin* is an excellent companion product to the many TAKAMINE enzyme products derived from bacterial and animal sources.

DIASTASES — For liquefaction and hydrolysis of starch to produce soluble dextrins and sugars. Also removes starch, eliminating filtration problems and turbidity.

PECTIC ENZYMES — For the hydrolysis of pectins in fruit and fruit juices in order to speed processing and to make fruit juices sparkling clear for consumer appeal.

PROTEINASES — For the modification and hydrolysis of proteins in food manufacturing and pharmaceutical operations.

GLUCOSE-OXIDASE — To prevent browning due to glucose or oxygen, and to increase shelf-life of beverage products.

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make it taste *better,*
look *better,* sell *better*

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DIVISION OF MILES LABORATORIES, INC. • CLIFTON, NEW JERSEY

Edward L. Carlson, advertising manager of Oakite Products, Inc., has been placed in over-all charge of the company's information services, including trade shows, special promotions, literature and publicity. Mr. Carlson, who joined Oakite in 1924, has been advertising manager since 1947.

Frank S. Kapral, former Michigan State football star and coach at Dartmouth College, has joined the sales force of the Flexible Packaging Div. of Nashua Corp., Nashua, N. H.

Wm. H. Case has accepted a post with the International Minerals and Chemical Corp. and will be located at their laboratories in Skokie, Ill. Mr. Case was formerly on the staff of the Quartermaster Food and Container Institute for the Armed Forces, Chicago.

Continued on page 66

EXPANSION NEWS

The Hazel-Atlas Glass Division of Continental Can Company, Inc., held an open house in mid-August to celebrate the addition of its fourteenth Glass Container Plant. The new plant, covering 30 acres, is situated in pleasant rural surroundings near Plainfield, Ill. Strategically located, 40 miles from Chicago, it is within overnight shipping distance from important processing and bottling centers — Wisconsin, Minnesota, Missouri, and Michigan. Continental's Hazel-Atlas Division includes the facilities of the former Hazel-Atlas Glass Division merged into Continental last September.

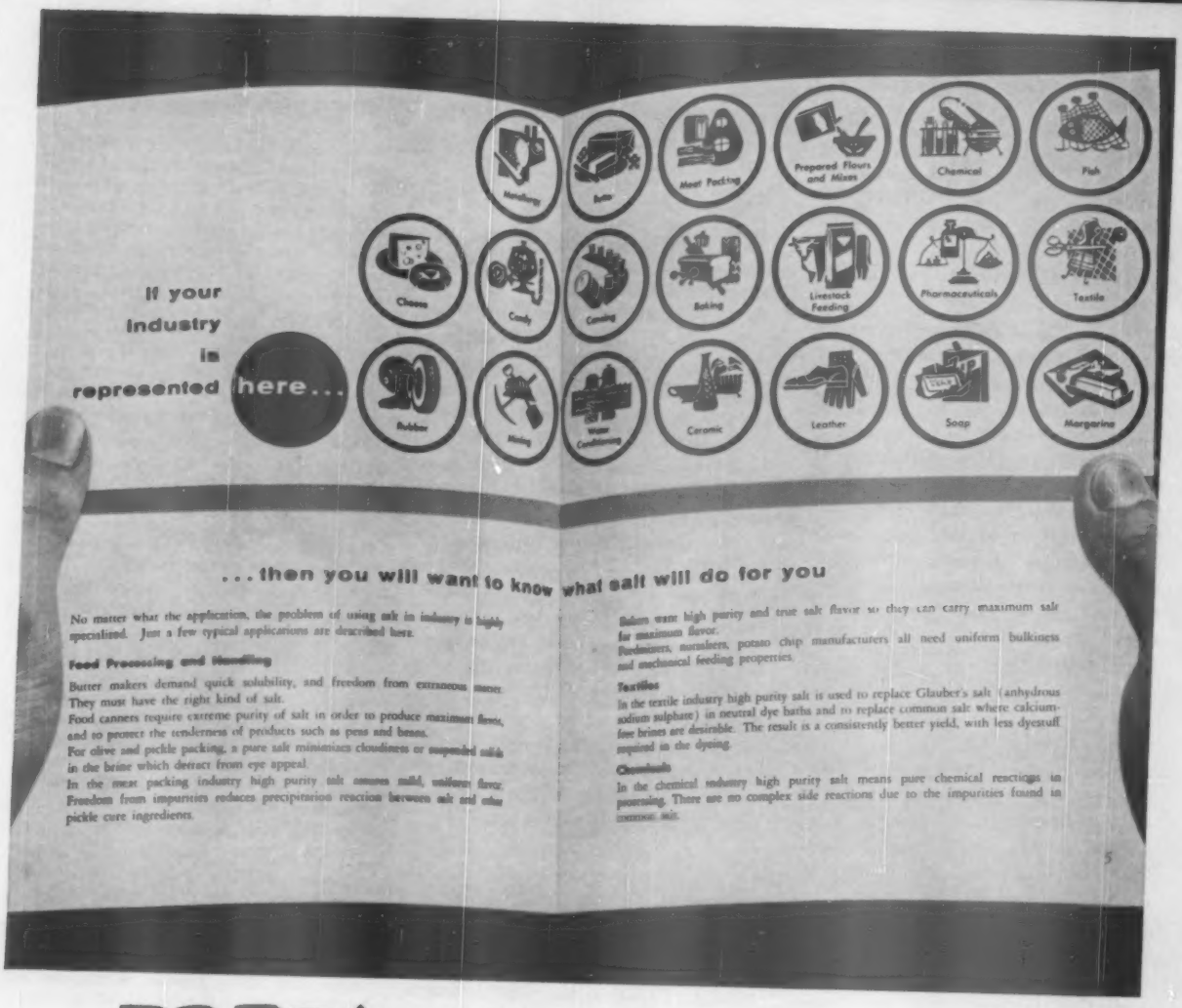
The Plainfield plant will serve the glass packaging requirements of the food, beverage, and industrial marketing centers. The Martin manufacturing facilities cover 119,384 square feet and in addition to melting furnaces include seven new container-making lines capable of producing up to 120 flint glass jars a minute. The plant is designed for easy doubling of these facilities. Present storage space is 91,860 square feet and this space is already due to be doubled in the near future. The shipping carton facilities will be quadrupled to keep up with demands. A trained staff of quality control specialists is maintained to keep vigilant watch on quality.

Excavation began recently for a new addition to the Kraft Foods research laboratories at Glenview, Ill., and work is expected to be complete by mid-November. The new structure, with 19,000 square feet of floor space, will be annexed to the present laboratory building. According to Charles W. Kaufman, a Kraft vice-president and director of research, the new addition is the result of the company's increasing activity in the field of research and new product development.

A special division to handle construction problems peculiar to the grain processing industries has been added to the organization of the Jones-Hettelsater Construction Co., 1911 Baltimore Ave., Kansas City 8, Mo. The new division will be available for consultation on modernization of existing facilities, analysis of operating costs, and design and erection of new structures.

A fully equipped foods development laboratory has been installed and staffed by Morningstar, Nicol, Inc., at Hawthorne, N. J. The new facility is intended to help the food processing industries obtain the benefits of new specialty starches and refined natural gums developed by the company. The laboratory also will conduct basic research in the food products area and will be co-ordinated with Morningstar's general research group, also located at Hawthorne. Work in this field will be under the direction of IFT member Leonard M. Waldt.

General Foods Corp. in midsummer began the first of a series of moves into this new multimillion-dollar research center, on a 55-acre site overlooking the Hudson River at Tarrytown, N. Y. When the move is complete, nearly 500 technical personnel will work in the administration, science, and development buildings (left to right). The company's present laboratory facilities at Hoboken, N. J., will be used for expanded coffee research by the Maxwell House division. In addition to the new Tarrytown labs, the company his 12 division research laboratories throughout the country.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Pharmaceuticals
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Water Conditioning
Ceramic
Leather
Soap
Margarine
...then you will want to know what salt will do for you
No matter what the application, the problem of using salt in industry is highly specialized. Just a few typical applications are described here.
Food Processing and Handling
Butter makers demand quick solubility, and freedom from extraneous matter. They must have the right kind of salt.
Food canners require extreme purity of salt in order to produce maximum flavor, and to protect the tenderness of products such as peas and beans.
For olive and pickle packing, a pure salt minimizes cloudiness or suspended solids in the brine which detract from eye appeal.
In the meat packing industry high purity salt assures mild, uniform flavor. Freedom from impurities reduces precipitation reaction between salt and other pickle cure ingredients.
Bakers want high purity and true salt flavor so they can carry maximum salt for maximum flavor.
Purifiers, tumblers, potato chip manufacturers all need uniform bulkiness and mechanical feeding properties.
Textiles
In the textile industry high purity salt is used to replace Glauber's salt (anhydrous sodium sulphate) in neutral dye baths and to replace common salt where calcium-free brines are desirable. The result is a consistently better yield, with less dyestuff required in the dyeing.
Chemicals
In the chemical industry high purity salt means pure chemical reactions in processing. There are no complex side reactions due to the impurities found in common salt.
5

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An old railroad roundhouse near Melrose Park, Ill., has taken a new lease on life since it was leased by Litheote Corp., New York City, which specializes in applying protective coatings to equipment used in processing, storage and transportation of food.

The lining of railroad tank cars for bulk shipment of liquids is a major part of Litheote's business. The roundhouse, fed by 17 sets of tracks, can handle 30 tank cars at a time, and provides what the firm believes is the nation's largest facility—43,000 square feet — for the application of interior protective coatings. Besides tank cars, the plant treats storage tanks, filter presses, vacuum tanks, liquid sugar tanks, cheese vats and drying equipment.

U. S. soldiers will get their first taste of the Army's experimental irradiated food prepared and served as part of a regular mess hall meal in a troop-acceptance test to be conducted this winter at Fort Lee, Va.

The test, designed to establish that food preserved by ionizing radiation is acceptable to troops on the basis of flavor and texture, will be conducted by the Quartermaster Research & Engineering Field Evaluation Agency.

The initial test will be confined to a single irradiated food which will be served several times during a 30-day period as part of a regular Army meal. The same dish also will be served several times during the test period in non-irradiated form. Troops will not be informed which version is being served. It is expected that the test will involve, on a voluntary basis, two companies of troops, or about 300 men.

The particular item to be served in the test will be selected from among several dozen food items that already have been taste-tested by military and civilian personnel, under laboratory conditions, over a period of more than four years. These taste tests have been conducted by the Food Acceptance Branch of the Quartermaster Food and Container Institute for the Armed Forces, Chicago.

"More food technologists are employed in the confectionery industry than ever before, and more of the sales dollar is spent for consumer advertising, merchandising and promotion than heretofore." So said Philip P. Gott, president of the National Confectioners' Assn., in an address at the 12th annual convention of the National Candy Wholesalers Assn. in Chicago recently.

"Candy craftsmen still exist," Mr. Gott said, "for art is still required to make a number of types of confections. However, the 50-pound batch has been replaced in many instances by continuous cookers which, for instance, can produce 1,000 pounds of hard candy per hour. The use of scientific instruments in the laboratory and in the plant have increased quality and decreased costs."

The European Packaging Federation (EFP) has announced it will hold its next congress concurrently with INTERPACK — the International Trade Fair of Packaging Machines, Confectionery Machines and Packaging Materials—which is scheduled for March 2–9, 1958, in Düsseldorf.

ABSTRACTS

Continued from page 54

in the serum during pregnancy. The serum levels of non-lactating mothers averaged 0.7 mg. per 100 ml. during the puerperium on intakes (during pregnancy) of 100 mg. or over per day; the serum concn. of lactating mothers did not average greater than 0.3 mg. even on intakes exceeding 120 mg. daily. Increased frequency of premature birth was limited to the lowest intake levels and lowest serum concn.

Dietary survey on Rarotonga, Cook Islands. II. Food consumption in two villages.

FRY, P. C. (Harvard School of Public Health, Boston, Mass.). *Am. J. Clin. Nutrition 5*, 260–73 (1957).

The evidence presented showed that 60 to 95% of the families consumed less than 75% of the Natl. Research Council's recommended intakes of Ca and riboflavin, and one-third of the families were in the same low category for vitamin A. It is important, however that the comparisons made between nutrient intakes and standards be regarded as tentative. The adequacy of a diet is detd. in the final analysis by the health of the population consuming it, and it can be said, on the basis of the present report, that within their short life spans, of about 40 years, Rarotongans do not show overt signs of suffering from widespread malnutrition.

ENGINEERING AND PLANT EQUIPMENT

Chemical cost and profitability estimation—1956 annual review.

WEAVER, J. B. (Atlas Powder Co., Wilmington 99, Del.). *Ind. Eng. Chem. 49*, 936–46 (1957).

Cites 387 articles on cost and profitability estn. Review incorporates a subject index which includes abandonment of projects, capital budgeting procedure, reliability of estimates, as well as equipment, process, and product categories.

Freeze grinding of foods.

ANON. *Food 26*, 226 (1957).

Pilot plant for freeze grinding, a new technique which is reported to have been successfully applied to dried almonds, apricot kernels, coconut, spices, ginger, cinnamon, pepper, etc., has been designed by British Oxygen Research & Development Ltd. The process is claimed to make possible the grinding of materials that may otherwise remain a sticky paste, and in such cases as above eliminate the risk of loss of flavor due to the evapn. of oils in grinding due to heat generation.

FOOD AND FOOD TECHNOLOGY

Baking and Bakery Products

Glyceryl monostearate (G.M.S.) in food.

CRESSEY, S. (Croda, Ltd., Engl.). *Food Manuf. 32*, 165–8 (1957).

An outline is given of the compn., properties and uses of G. M. S. in food products generally, with particular reference to theories about its effects in bread.

Cocoa and Cocoa Products

Cacao fermentation.

SWAIN, T. (Univ. of Cambridge, Engl.). *Chemistry & Industry 1957*, 543–4.

It is suggested that a phase of mobilization of enzyme systems hydrolyzing anthocyanidin glycosides and the cell-wall constituents of the polyphenol storage cells must precede the killing of the bean if a final product of good quality and proper chocolate flavor is to be obtained. A review.

Confectionery Products

A new look at "frozen candy".

KNECHTEL, H. *Mfg. Confectioner 37*, 17–20, May 1957.

Chocolate covered candies have been stored for 8 mos. in the frozen state. Triangular panel testing failed to identify the stored sample by comparison with fresh samples. Some of the problems, costs and advantages, of frozen storage for candies are discussed.

Feedstuffs

Changes induced by autoclaving a solvent-extracted cottonseed meal.

CONKERTON, E. J., MARTINEZ, W. H., MANN, G. E. AND FRAMPTON, V. L. (Southern Regional Research Lab., Southern Utilization Research and Development Division, U.S.D.A., New Orleans, La.). *J. Agr. Food Chem. 5*, 460–1 (1957).

The effect of autoclaving a prime-quality solvent-extd. meal upon its sol. protein fractions was studied to det. chem. differences between cottonseed meals of known and varied nutritive value. Portions of both the original and the autoclaved meal were fractionated, by successive extns., with water, saline, and dil. alkali. Autoclaving modified the soly. behavior of the cottonseed protein, and reduced the sugar, lysine, and arginine contents of the meal. Results showed that simple measurement of the soly. of N in the meal, commonly used to indicate the degree of heat damage to a meal, does not reflect the complete change induced in cottonseed protein by heat.

Flavors and Flavorings

Experimental media for evaluating flavor.

SWAINE, R. L. (Arthur D. Little, Inc., Cambridge, Mass.). *Coffee & Tea Ind. 80*, 93–4, June 1957.

A series of simple media that allows to make flavor evaluations without immediately resorting to the final product are described.

Meat and Fish

Fish products as protein supplements to cereals.

CARPENTER, K. J. AND ELLINGER, G. M. (Rowett Research Inst., Bucksburn, Aberdeenshire). *Brit. J. Nutrition 11*, 162–73 (1957).

A no. of dehydrated fish products were tested as supplementary proteins to cereals by the standard 'gross protein value' technique with chicks. Those prepd. for human consumption proved superior to the casein that was used as the standard. Commercial fish meals gave values approx. 10% below those of prepn. made by low-temp. drying processes. The value of vacuum-dried cod fillets, packed in N at 2–3% moisture content, was not significantly reduced by holding the product at 100° for 31 hr. despite considerable browning and formation of ammonia. Similar fillets raised to 11% moisture content and held at 105° for 36 hr. showed reduction of approx. 28% in nutritive value. The addn. of lysine to the heat-damaged fillets and to a com. fish meal raised their value; no such effect was obtained with high-quality vacuum-dried fillets. A chem. measure of 'available lysine' obtained by reaction of the test materials with fluorodinitrobenzene and subsequent estimation of ε-dinitrophenyl-lysine after hydrolysis showed a close relationship with the biol. results.

PHYSICAL RESEARCH

Propeller cavitation.

BORGENSTAM, C. *Tek. Tidskr. 86*, 767–76; *Chem. Abstr. 51*, 2350f (1957).

Cavitation (I) in liquids occurs at low pressures and high velocity. The classical theory explains I by assuming evapn. on the suction side, spreading of the vapor film, and local collapse with "implosion" and consequent erosion of the surface. It has been found in tank expts., however, that under some conditions I did not occur with pressures below the crit. one. Dissolved gases are important and more so with "film I" than with "bubble I". Danger of I decreases with diam. of the microscopic vapor bubbles. The singing vibration sound is due to rapid condensation-evapn. The material damage may be due to a combination of mech., electrolytic, and chem. action. Stainless steel is one of the most resistant construction materials. Nylon surfaces on small propellers are remarkably resistant.

RADIOCHEMICAL TECHNOLOGY

Inactivation of infectious nucleic acid from tobacco mosaic virus by ultraviolet light.

MCLAREN, A. D. AND TAKAHASHI, W. N. (Depts. of Soils and Plant Nutrition, Univ. of California, Berkeley, Calif.). *Radiation Research 6*, 532–41 (1957).

Infectious nucleic acid from tobacco mosaic virus is inactivated by u. v. light (2537 A°). Inactivation takes place without a reduction in intrinsic viscosity but with a slight reduction in optical density at 2600A°. The naked nucleic acid is about six times as sensitive as it is in the form of intact virus.

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INDUSTRY PUBLICATIONS

Continued from page 56

Among **AEC Health and Safety Studies** recently released for sale to the public were three of special interest:

AECU-3488, *Worldwide effects of atomic weapons, Project Sunshine*, August 1953, 104 pp., 55 cents;

ORNL-2304, *A study of the distribution and excretion of uranium in man; an interim report*, 58 pp., 40 cents;

UR-487, *Species differences in the metabolism of* Po^{210}, April 1957, 17 pp., 20 cents.

Copies can be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

Tapioca Flour, its nature and uses, are discussed in Laboratory Report A-810-M1 recently published by Morningstar, Nicol, Inc., 630 W. 51st St., New York 19. The report includes a description of the derivation, manufacture and properties of tapioca flour and lists a number of uses based on its unique properties.

New **Materials Handling** methods for frozen-food warehouse and wholesale operations are described in a series of three folders published by the Rapids-Standard Co., 342 Rapistan Bldg., Grand Rapids 2, Mich. Entitled "Frozen Food Handling Ideas," the folders illustrate new equipment designed to speed and simplify warehousing operations.

Bardex Tubing, a new type of reinforced plastic tubing, is described in a leaflet—which also includes a sample of the product—just released by Newage Industries, 222 York St., Jenkintown, Pa. The leaflet includes complete specifications for the tubing, which is said to be especially suitable for use under hard conditions of flexing.

A catalog of 118 technical reports in the field of **Packaging and Materials Handling** in the collection of the Office of Tehnical Services, U. S. Department of Commerce, has been published. Some of the reports are the results of research performed in this country under contract to the armed forces or other government agencies; others are German documents captured in World War II.

The catalog, CTR-72, *Packaging and Materials Handling, 1941–57*, can be obtained for 10 cents from OTS, U. S. Department of Commerce, Washington 25, D. C.

PERSONNEL

Continued from page 62

Paul Dearborn has been appointed to the new post of director of packaging markets for Reynolds Metals Co. From headquarters at the company's general sales offices in Louisville, Ky., he will direct the efforts of all packaging market managers. Mr. Dearborn, who has been with Reynolds since 1950, formerly was with the W. W. Bevan Co. and the H. D. Catty Corp., Massachusetts packaging converters.

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